A STUDY TO EVALUATE
THE SYLLABUS OF TRAINING
FOR THE ROYAL AUSTRALIAN AIR FORCE
NAVIGATOR COURSE

THESIS

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AFIT/GLM/LSR/90S-19

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Presented to the Faculty of the School of Systems and
Logistics of the Air Force Institute of Technology
Air University
In Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Logistics Management

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September 1990

Approved for public release; distribution unlimited

Acknowledgements

This thesis would not have been possible without the assistance of several other people. I would first like to express my sincere gratitude to my advisor, Dr. David K. Vaughan of the Department of Communication and Organizational Science, School of Systems and Logistics, for his advice and constant encouragement.

I would also like to thank WGCDR Ken Given and SQNLDR Steve Glover who provided the necessary training documents and occupational analysis data for the study, and who were always willing, despite their own workloads to offer advice, answer my questions and provide "news from home".

Finally, to my wife, Charlotte, and our daughters Tiffany and Nicole, who have shared the frustrations and sacrifices that are inherent in the thesis process: thank you for your understanding and support. The week-ends are now free again and Daddy can come out to play.

Richard Fogg

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Abstract

The primary aim of this thesis was to address a need for an independent evaluation of the RAAF Navigator Course which was expressed by staff officers in Air Force Office in early 1989. Although several occupational analyses have been completed on the RAAF Navigator Category, and informal talks between School of Air Navigation (SAN) instructors regularly occur, an independent, a formal evaluation of the navigator course had never been carried out.

The study first reviewed the literature on education and training with emphasis on theory applicable to the design of instructional systems. The Instructional Systems Development (ISD) process, as used by the USAF for the development and design of training courses was then examined as a basis for evaluation of the RAAF Navigator Course. This required a comparison of RAAF and USAF training philosophies to ensure that the ISD model was compatible with the aims of RAAF training and therefore suitable as a tool to evaluate the syllabus of training currently used for the RAAF Navigator Course.

Occupational Analysis data from a 1988 study of the RAAF Navigator Category, and the content and theoretical construct of the syllabus of training for the RAAF Navigator Course were then analysed on the basis of a four-step process based on the USAF ISD model. During the course of

the study, an amendment to the flying training section of the syllabus was proposed by the RAAF School of Air Navigation which addressed some of the issues which had prompted the research. This amendment was therefore reviewed in conjunction with the existing syllabus.

Overall, the course was found to meet its aim in providing graduates capable of performing the basic duties of a junior commissioned navigator in the RAAF as identified by the occupational analysis. However, some shortcomings in the syllabus, and therefore the course, were identified and recommendations based on these findings were proposed.

A STUDY TO EVALUATE THE SYLLABUS OF TRAINING FOR THE THE ROYAL AUSTRALIAN AIR FORCE NAVIGATOR COURSE

Training is the key mechanism for effective military force and weapons system utilization and maintenance.

General William E. Depuy (12)

I. Introduction

General Issue

The role of training in a military organisation cannot be overemphasised; armed forces require properly trained personnel in order to fulfil their roles in the defence of the nation and its area of strategic interest. Training consumes a significant proportion of the Royal Australian Air Force (RAAF) budget and a major expense is the initial training of aircrew personnel. Budgetary constraints require the most efficient use of those funds.

Military aviation is a specialised and demanding occupation which requires extensive training to provide the necessary skills. The RAAF School of Air Navigation (SAN) has been responsible for the preliminary training of navigators for operational flying duties in the RAAF since 1946, and has provided training for navigators of the Air Forces of several regional countries including Malaysia and Singapore. Training of Observers for the Royal Australian Navy is also conducted by SAN.

The present syllabus of instruction for basic navigator training, developed during the 1960s, has been regularly amended to reflect operational squadron requirements so far as SAN has been able to

accommodate them. (Note: In the United States of America, the term curriculum is used to describe a set of courses which comprise an educational program. In this thesis the term syllabus refers to both the curriculum and the document which describes it, and course refers to the set of subjects which comprise the program described by and contained in the syllabus).

With the exception of a major change to navigator training following the demise of the Air Electronics Officer category in 1979 (see Chapter II), syllabus amendments have arisen largely as a result of regular 'validation visits' to the operational squadrons by Headquarters Support Command (HQSC) staff (now Training Command staff), and SAN instructors. The visits elicit subjective comments from squadron executives on their perceptions of the standard of graduates and aim to "establish the abilities and personal characteristics graduates should have acquired on completion of their course" (33:1).

Historically, the syllabus changes resulting from these visits have been relatively minor, or concerned personal qualities and officer development issues. Comments similar to "Squadrons visited indicated that they were reasonably well satisfied with the quality of SAN graduates received (29:4)" are representative of visit reports pertaining to navigator training over the last 5 years.

Consequently, much of the syllabus emphasis remains on basic aerial navigation techniques, concentrating on manual plotting of dead reckoning position from visual, radio, and celestial fixing methods and a strict adherence to a formal cycle of procedures and log keeping activities. Rudimentary automatic track-keeping is taught using an analog computing device developed in Great Britain during the 1950s with

input from a similar vintage doppler radar; neither system is used operationally. Although a modification program to upgrade the navigation equipment in the training aircraft has been approved in principle, that program has yet to be commenced (30).

Since 1978, all aircraft delivered to the RAAF which require navigator aircrew have been fitted with state of the art inertial navigation equipment, and the requirement for continuous manual plotting of aircraft position has been reduced significantly as a result. The role of the navigator has become one of systems manager and, in most squadrons, aerial tactician/weapons system operator. Yet, the emphasis in basic training remains on the manual skills of the art.

The role of the navigator in the RAAF of the 1990s and the ever increasing costs associated with training provide grounds for an investigation to ascertain if major modifications to the *syllabus of* training to more accurately reflect the technological environment and the tactical nature of the role are required. In addition, the apparent *ad hoc* nature of syllabus amendments on the basis of informal 'validation visits' to the operational squadrons suggests that a more formal evaluation of the RAAF Navigator Course may be required to ensure that the course terminal objectives are both applicable to the RAAF need and are being met by the present course.

Specific Problem

Although regular reviews of RAAF training courses are performed, there is no evidence to indicate that a formal evaluation of the type proposed in this thesis has been carried out on the RAAF Navigator Course. Such an evaluation was suggested in the recommendations from

the report of an occupational analysis on the Navigator category which was released in 1988 (28:23), but had not occurred at the time this research was initiated. In addition a 1989 staff communication within Air Force Office (13) states *inter alia*:

> Although Occupational Analysis surveys have been completed on the Navigator Category, and informal talks between SAN instructors and operational squadron staff are carried out regularly, an independent, formal validation of the navigator course has never been carried out. Given the changes in navigational techniques and technology over this period, a formal validation of the course is well overdue. (13:3)

Thesis Aim

The aim of this thesis is to evaluate the syllabus of training currently used for the RAAF Navigator Course in terms of an external measure of curriculum design and the training requirements for RAAF Navigators identified in the 1988 Occupational Analysis of the RAAF Navigator category mentioned above. The Instructional Systems Development (ISD) process, used for the development and accomplishment of education and training programs in the United States Air Force and described in Air Force Manual 50-2 (AFM 50-2), will be examined as a possible model for accomplishing this aim.

Proposed Methodology

The study will first compare the training methodology employed by the RAAF and governed by Defence Instruction (Air Force) AAP 2002.001, Manual of Training Policy and Procedures, with current theories in the education and training literature, and with the ISD model used by the USAF. This comparison will be used to test whether there are significant differences in training methodology which would preclude the ISD model as a basis for evaluation of the RAAF Navigator Course.

The syllabus content will then be compared with the results of the 1988 occupational analysis performed on the navigator category. This comparison should determine if elements of the course are redundant or should be made more relevant to present operational requirements (and those likely over the next decade and beyond), to ensure that the RAAF is obtaining value for the significant investment in the basic training of navigator aircrew. Finally, the contents of the present syllabus of training for RAAF navigator training will be assessed against the criteria required by the Manual of Training Policy and Procedures to test compliance with policy and also against the ISD process as a cross check of validity in terms of contemporary academic theory and an academically recognised model for curriculum development.

Research Questions

In order to achieve the aims of this thesis, the following general research questions are examined:

1. Does the syllabus of training for RAAF navigators adequately reflect the training required by an SAN graduate in order to transition to operational flying duties?

2. Does the current RAAF Navigator Course contain material that is not relevant to present operational squadron requirements, or material that is more applicable to squadron conversion training?

3. Are there significant differences in training methods and ideologies between the USAF and the RAAF and if so, can the RAAF benefit by adopting USAF training methodology?

Investigative Questions

To refine these general questions into more specific guidelines for research, the following investigative questions are proposed:

1. Which of the fundamental responsibilities of a RAAF Navigator, as identified by the 1988 survey, require essential training at SAN and which are merely desirable?

2. Are the responsibilities of a RAAF navigator which require training adequately reflected in the course objectives as defined by the syllabus of training?

3. Is there any material contained in the syllabus which may be considered redundant or which is better taught during squadron conversion?

4. What are the specific training standards, and how are they reflected in the syllabus?

5. What measurement criteria are used to determine effectiveness of the training?

6. How well is the course meeting the needs of the operational squadrons?

7. Does the syllabus of training for the RAAF Navigator Course (and therefore by inference the RAAF Manual of Training Policy and Procedures) reflect the currently accepted theories and general literature in education and training?

8. Does the ISD model reflect the current theories in education, and if so, will a direct comparison of the RAAF

Navigator Course syllabus with the ISD provide a means to validate the RAAF course in terms of:

a. Skill and knowledge requirements for graduate navigators;

b. Training objectives to meet these requirements;

c. Training methods to impart the knowledge and skills;

d. Evaluation methods to test that the training objectives are met; and

e. Feedback from squadrons to ensure that future graduates can satisfactorily transition to operational flying duties?

These questions are examined in subsequent chapters of this thesis and the results of the research are presented in Chapter V.

Chapter II provides background information on the general role and organizational structure of the RAAF and the role of military aircraft navigators. The chapter also describes the RAAF navigator course in general terms and briefly introduces the syllabus of instruction. Chapter III begins with a review of the education and training literature concentrating on theories central to the development of the ISD model. This model is then examined as a possible framework for evaluation of RAAF navigator training. Chapter IV describes the methodology employed to conduct that evaluation and answer the investigative questions posed above. Chapter V contains the analysis and discussion of results and Chapter VI provides a conclusion and recommendations arising from the research.

Scope of Research

This research is limited to the RAAF Navigator Course conducted at SAN as described by Defence Instruction (Air Force) AAP 2412.100, Syllabus of Air Training Course Navigator, amended by Amendment List 2 dated March 1985 (39). This is the authoritative document for conduct of the course. However, during the course of the research, a proposed amendment was submitted to Headquarters Training Command by SAN (32) which addressed many of the issues raised in the 1988 Occupational Survey Report, a major source of data for this thesis. Although not officially sanctioned, the new syllabus is under test with the present course and is expected to be incorporated officially for No 79 Navigator Course which begins in September 1990 (31). Therefore, present syllabus content modified by the proposed amendment will be evaluated as per the amendment.

Other courses of training commonly undertaken by navigators are not discussed at any length in this thesis. Initial officer training courses at Officer Training School (OTS) are assumed to be satisfactory to meet the requirements of a junior commissioned officer in the RAAF. Post graduate training courses for navigators, such as the Aircraft Systems Course conducted at SAN, are career development courses which may improve an individual's ability to carry out his responsibilities as an operational navigator but are not necessary to do so.

Operational conversion courses to enable transition to squadron duties are fundamental requirements after graduation from SAN but are not examined in any detail in this research. There is evidence of overlap between conversion courses and the basic navigator course in the May 1988 Occupational Survey Report (28:18) and follow-on research to

positively identify such overlap may be desirable. However, because of time limitations and difficulties arising from the remote locality of the researcher from the relevant data, that overlap will not be examined in this thesis as fully as would be possible under more ideal circumstances.

Summary

This chapter identified a need for a formal evaluation of the RAAF Navigator Course and posed a set of research and investigative questions which form the framework for such an evaluation. The result of research to find answers to these questions is presented in the following chapters. In answering these questions, the author hopes to highlight any theoretical shortcomings in the current syllabus of training for RAAF Navigators and provide recommendations for improvement.

II. Background

Some readers may not be familiar with the RAAF and/or the role of navigators on modern military aircraft. This chapter provides background information on both and also describes the RAAF Navigator Course in general terms.

The Royal Australian Air Force

Responsibility for the defence of Australia rests with the Australian Defence Force (ADF), a tri-Service organisation of approximately 72,000 permanent military personnel (supplemented by almost 30,000 reservists). The Royal Australian Air Force as one of the three military branches of the ADF, has the following objectives:

1. provide air forces structured for credible air contingencies in defence of Australia, its territories and approaches, generally as part of a joint force, and including support of maritime and land operations, and

2. longer term expansion should this be required. (7:17)

The RAAF comprises approximately 21,000 uniformed personnel (including 700 pilots and 300 navigators) and an inventory of almost 450 aircraft including 74 McDonnell Douglas F/A-18 Hornets, 22 General Dynamics F-111C aircraft, and 20 Lockheed P-3C Orions (7). With 17 front line flying squadrons, the RAAF is a small but technologically advanced force by world standards, but it is the dominant element of airpower in the Australian region.

RAAF Organisation

To meet its objectives, the RAAF is organized into three functional commands; Air Command, Logistics Command, and Training

Command, and a directing component, Air Force Office, the RAAF headquarters element within the Department of Defence. Logistics Command and Training Command have only recently evolved as separate commands, having been split from the now defunct Support Command in November 1989.

Air Command is divided into five groups commensurate with the operational role of the elements therein, namely, Airlift, Strike/Reconnaissance, Tactical Fighter, Tactical Transport, and Maritime Patrol. These groups are further divided into Operational, Maintenance, and Base Support Wings and the wings into individual squadrons. As their titles suggest, the other two commands provide the logistics and primary training support for the combat forces, although each operational wing remains responsible for the conversion and continuation training of its aircrew and maintenance personnel.

<u>RAAF Aircrew Training</u>

Initial aircrew training is the responsibility of Training Command, based at RAAF Point Cook in Victoria. Pilot and navigator trainees are recruited mainly from the civilian world but also from within the ranks of serving airmen and some officer categories of the RAAF. Non-graduates of the RAAF Officer Training School (OTS) are required to undergo 12 weeks of officer training at OTS prior to commencing aircrew training.

Preliminary pilot training is conducted at No 1 Flying Training School (1FTS), RAAF Base Point Cook, with completion at No 2 Flying Training School (2FTS), RAAF Base Pearce. Non-commissioned aircrew such as flight engineers, loadmasters and specialist sensor-systems operators

on maritime patrol aircraft, are trained at the Airman Aircrew Flying Training School (AAFTS) at RAAF Base Edinburgh.

Prior to 1979, the RAAF possessed three commissioned (officer) aircrew categories, Pilot, Navigator, and Air Electronics Officer (AEO). AEOs were employed on maritime patrol aircraft to operate the specialist sensor and tactical communications systems specific to these aircraft. The Navigator and AEO categories were combined in 1979, and navigators on P3 aircraft performed these functions until 1987. Non-commissioned Air Electronics Analysts, introduced in 1984, now perform the sensor operator duties.

Current Role of the Military Aircraft Navigator

The traditional responsibilities of a navigator, in any mode of transportation, have been the determination and maintaining of a record of position, directing the way to destination, avoiding collision, monitoring fuel consumption, and timekeeping (44:751). Increased scientific knowledge has produced advances in technology which now allow these tasks to be performed by automatic devices with far greater accuracy and speed than the human practitioner. This is particularly so in the field of commercial aviation where almost all air transport operations which previously relied on human navigators have been performed without them since the early 1970s.

If aircraft navigation has become automated, why do military forces throughout the world continue to train navigators for flying duties? The military uses of aircraft are more diverse than commercial transport operations, and while routine navigation responsibilities can be handled by machine, the overriding fact remains that military

aircraft systems are susceptible to combat damage and may require human intervention to achieve mission success.

The task inventory for Royal Australian Air Force navigators at Appendix A also identifies crucial tasks which as yet remain in the domain of the human operator. Operation and interpretation of tactical displays, programming and in-flight update of weapons systems, visual tactical navigation and terrain avoidance, and monitoring/backup of pilot performance during high stress operations are examples of such tasks. While current USAF research in Artificial Intelligence includes a pilot's advisor that aims to assume many of these responsibilities, such a system is far from operational and is unlikely to replace human navigators in the USAF, let alone the RAAF, in the short term.

Therefore, while the requirement for navigators has declined over the years since World War II, navigators still have a function in many of the weapons systems presently in service with the RAAF, namely F-111C Strike/Reconnaissance aircraft, P-3C Orion Maritime Patrol aircraft, and C-130 Hercules Transport aircraft. Given budgetary constraints and the present force requirements, these aircraft are likely to remain operational into the next decade and a requirement will exist for navigator aircrew with the present responsibilities for that long and probably longer.

A recent study by staff in the Directorate of Personnel-Air Force predicts a training requirement for navigators of 24 in Fiscal Year 1993/94 and 22 in 1994/95 (13). That rate is well above the graduation rate for calendar year 1989 which saw 13 of the original 18 students graduate as RAAF navigators (34). Therefore, an evaluation of navigator training may also identify factors which may improve the graduation rate

and although that is not the primary aim of this thesis, such a study is worthy of research.

The Current RAAF Navigator Course

Basic navigator training is conducted at the School of Air Navigation (SAN) situated at RAAF Base East Sale, 216 kilometres (135 miles) east of Melbourne, the Victorian state capital. Graduates are then posted (assigned) to role-specific training squadrons for conversion training prior to commencing duties with an operational flying squadron.

Defence Instruction (Air Force) AAP 2412.100, Syllabus of Air Training Course Navigator, is the RAAF document which governs the conduct of the RAAF Navigator Course (39). The syllabus states that the aim of the Navigator Course is:

> to train members to perform the basic duties of a junior commissioned navigator in the Royal Australian Air Force. The graduate will require operational conversion training before being employed as a navigator in an operational squadron. (39:1)

The course duration is 51 weeks, each week comprising 38 fifty-minute periods for a total of 1,884 programmed periods, and a one week mid-course break. Air training exercises include 7 hours flying in the CT4A Airtrainer (a single-engine two seat aircraft used for basic pilot training), followed by 227 hours of planned flying in the twin-engine Hawker Siddeley 748 Navigation Trainer aircraft (HS748NT), a commercial 44 seat airliner converted for navigator training.

The majority of the course is spent in a traditional academic environment, the formal classroom. The theory and skills of air navigation, first taught in this environment, are then practiced in a simulator which closely resembles the navigation station in the training

aircraft. The student's ability to apply these skills in the air is then developed and tested in the aircraft.

Generally, two students and one instructor fly a six hour sortie with each student having responsibility for the actual navigation of the aircraft for half of the trip. The student navigating the aircraft is supervised and formally assessed on the navigation by the instructor; the aircraft captain provides a subjective assessment of the student's contribution to the mission as a crew-member. The other student utilizes the unassessed three hours for practice and reinforcement of skills without the pressure of evaluation.

In addition to navigation, the syllabus includes academic training in related subjects such as mathematics, physics, meteorology, radio communications, air traffic control, compass theory, electronics and computers. Military subjects including weapons, operations management, RAAF procedures, and drill are taught as are current affairs, physical fitness, and communication both written and oral. A summary of course breakdown by subject and period allocation is provided at Appendix B.

The syllabus does not define a specific graduation standard except to say that to achieve graduation status,

> the graduate must be capable of undertaking the duties of an aircrew officer and continuing with further officer education programmes. The graduate will require further training before being employed as a navigator in an operational squadron. (39:2)

Section One of the syllabus is referred to as the Graduation Requirement and contains Course Terminal Objectives (CTOs) which specify general training objectives in terms of the knowledge and skills to be trained. The objectives include an attainment level, in terms of a code defined in the syllabus, for each of the subjects comprising the course. The

attainment codes are listed at Appendix C and the apparent shortcoming in prescribing a specific graduation requirement will be discussed in Chapter V.

The remaining sections of the syllabus contain the Syllabus Objectives. These represent a breakdown of each CTO into more specific objectives which detail the knowledge and skills necessary for a student to satisfy the parent CTO. As with CTOs, the Syllabus Objectives state an attainment code from the list provided at Appendix C.

Summary

This chapter has presented background material to prepare the reader for the discussion to follow. The organisational structure and role of the RAAF was discussed in general terms and a need for trained navigators as part of that structure was provided. The chapter also outlined the RAAF Navigator Course and introduced the syllabus of training of that course.

III. Literature Review

The literature in education is extensive and this review does not attempt to provide a chronicle of the significant number of theories that have been proposed to explain or improve human learning. Instead, the review will seek to identify those theories and factors which are relevant to the training philosophy of the RAAF and those which provide a means to evaluate the effectiveness of the RAAF Navigator Course.

General Theories of Learning

Glaser and Litko defined learning as the "acquisition of a behavior brought about, deliberately or not, by the learning environment" (19:235). Kimble and Garmezy define learning as a relatively permanent change in behaviour that results from reinforced practice or experience (22:133). Daft and Steers provide a concise review of the three principle theories that are currently accepted as fundamental to the learning process: 1) classical conditioning, 2) operant conditioning, and 3) cognitive learning theory (6:49), and this treatment is summarised in the following paragraphs.

Classical Conditioning Theory

Proposed by the Russian physiologist Pavlov in the early 1900s, classical conditioning theory stemmed from the well-known experiments with dogs taught to salivate at the sound of a bell. The theory focusses on a process by which a link is established between a conditioned stimulus (the bell in Pavlov's experiment) and an unconditioned stimulus (meat). Dogs naturally salivate at the sight of

meat (an unconditioned response). By repeatedly exposing a dog to both stimuli at the same time, a link was formed between the bell and the meat such that the dog salivated at the sound of a bell even when no meat was visible. The dog had learned to associate the sound of the bell with the sight of food and responded accordingly (6:50).

Operant Conditioning

Skinner believed that classical conditioning did not describe complex learning and criticized the theory as explaining only reflexive behaviour, a limited part of learning (42:503). He proposed a theory of operant conditioning, an extension of Thorndike's "law of effect" (43) which postulated that behaviour resulted in an outcome which could be either pleasurable or not. Behaviour which led to a pleasurable outcome or reward was likely to be repeated while less pleasurable or unpleasant behaviour was not (42:503-515).

Daft and Steers report that operant conditioning theory has three important concepts:

1. Drive: A felt need. A drive or desire to learn must be present for learning to take place.

2. Habit: The connection between stimulus and response as a result of previous experience which can determine behaviours or chosen courses of action.

3. Reinforcement or Reward: Feedback received as a result of a particular behaviour or action. (6:51)

The stronger the drive and habit, the more an individual is likely to behave in a certain way. In addition, feedback received may reduce the drive because a need has been satisfied, and may also reinforce the habit because of that satisfaction, thus increasing the likelihood of a

repetition of the behaviour under similar circumstances at a later time (6:51).

Classical conditioning and operant conditioning are examples of behaviourist theories. They are important from the standpoint that instructors can control the learning experiences of their students by manipulating the environment in a way to seek a response that can be rewarding and thus promote learning, but they do not explain all facets of the learning process.

Behavioural Factors Affecting Learning

In addition to its importance as a fundamental theory of learning, operant conditioning is also tied to behavioural research in the field of motivation by virtue of a common basis in Thorndike's "law of effect." The reinforcement theories of motivation described by Luthans and Kreitner are reported in the AFIT thesis of Wing Commander Graham Rowe (36). Rowe proposed that learning, motivation, and evaluation, factors identified by Biehler (3) as fundamental to student performance during a course of training, were the principal factors which could be examined in RAAF pilot trainees (36:46-47). A similar study may well prove beneficial to RAAF navigator trainees but is beyond the scope and intentions of this thesis.

Cognitive Theory of Learning

Piaget's cognitive theory, reported by Mussen *et al*, is an alternative means to explain learning as the mental activities involved in the acquisition, processing, organisation, and use of knowledge (25:219). This is a completely different approach from that of the

behaviourist theories. The mechanics of cognition involve classifying learning outcomes as either

> Assimilation: new ideas interpreted in terms of ideas an individual had already learned; or
>
> Accommodation: a new idea cannot be assimilated because there is no obvious link to past learning so accommodation occurs to restructure or modify an existing concept (25:224-225).

This model implies that an individual will attempt to seek cognitive harmony or equilibrium where the environment has been fully assimilated or has been accommodated. An individual out of equilibrium would be unable to explain the new environment and would seek to accommodate by changing his or her understanding of the world (25:225).

The distinction between cognition and behavioural theory is that while cognitive psychologists explain learning by examining what is occurring inside the head of the learner (how a student thinks or feels), the behaviourists are concerned with how a student acts as a result of the learning experience. The two theories are not mutually exclusive and many instructional systems use a combination of the two. However, to be effective, instruction also requires feedback. The instructor desires to know how much the student has learned; student behaviour provides the means to measure that understanding. The *USAF Handbook for Air Force Instructors*, Air Force Manual 50-62, proposes that an approach to training which uses the idea of cognitive learning while measuring behavioural outcome is an appropriate methodology (8:2-1).

Evaluating Educational Outcomes

The notion of measuring the outcome of a learning experience suggests a range of comprehension. Bloom's taxonomy of Cognitive Domain (4) provides a hierarchy of learning which relates to mental activity, and Krathwohl's taxonomy of Affective Domain provides a hierarchy in terms of state of mind (8:2-3, 23). These taxonomies, depicted in Figures 1 and 2, and others which have been developed along similar lines, provide the means for measuring behavioural outcome as a result of a learning experience.

Measurement of level of learning can be achieved by assigning an observable behaviour to a level of learning; for example, in the Bloom taxonomy, knowledge can be demonstrated by asking the student to simply recall and state previously presented material. Analysis, on the other hand, requires a student to be able to determine relationships with the learned material.

Cognitive Domain

Level of Learning	Mental Activity
Evaluation	Exercise of learned judgement
Synthesis	Create new relationships
Analysis	Determine relationships
Application	Use of generalization
Comprehension	Translate, interpret, extrapolate
Knowledge	Recall and recognition

Figure 1. Bloom's Taxonomy of Educational Objectives (8:2-2)

Affective Domain	
Level of Learning	**State of Mind**
Characterization	Incorporates value into life-style
Organization	Rearrangement of value system
Valuing	Acceptance
Responding	Reacts voluntarily or complies
Receiving	Willingness to pay attention

Figure 2. Krathwohl's Taxonomy of Educational Objectives (8:2-3)

The traditional testing of learning outcome that has evolved is geared primarily to classroom evaluation and involves a variety of testing methods which rate students on a comparative basis to produce grades that usually approximate a normal distribution (2:175).

However, this traditional approach is not without its critics. In a comprehensive study of research into student evaluation, Crooks (5) cites a 1983 study by Fleming and Chambers which found that 80% of all questions in typical tests of learning outcome at institutions ranging from elementary school level through university graduate school level are at the knowledge level of Bloom's taxonomy. Such tests frequently "failed to test stated instructional objectives by requiring little more than repetition of material from a book or lecture" (5:442). In addition, the study found that traditional normative testing produces undesirable outcomes including reduction in intrinsic motivation, anxiety, lowered self-efficacy and an over-emphasis on grades as opposed to the outcome being tested (5:468). Addressing an international

symposium on Applied Learning Technology in 1976, George A. Baker III, Professor of Management at the US Naval War College, described the traditional approach as a failure oriented strategy because only a few students will do well and few will master the material being taught (2:175). Military training, to be effective, requires all students to master training tasks. Baker described a systematic approach to training that

> yields instruction wherein the competencies expected of students upon exit from any instructional program are agreed to in advance, provide a firm foundation for the next program of instruction or for job performance, and the learning activities and related instructional strategies are designed to assist the student in acquiring and demonstrating the specific competencies. (2:175)

An application of this approach is the Instructional Systems Development (ISD) process, used by all branches of the US military for the development and design of training programs. This process has evolved from the application of General Systems Theory to the field of education and training.

A Systems Approach to Education and Training - Evolution of ISD

Between 1912 and 1950, a concept in psychology was developed which attributed job performance to a combination of training, management, and selection factors. In addition, the principles of systems theory, long established in the biological sciences, were applied to the study of human behaviour. These factors had a direct bearing on educational research, particularly during World War II because of the urgent need for thousands of personnel to be trained for specific and specialised jobs required by the military, and a requirement to meet this need as efficiently and cost-effectively as possible (21:207).

Published in 19 volumes, Flanagan's *Army Air Forces Aviation Psychology Program Research Reports* (15) contain the first major research into training based on an analysis of the tasks required of pilots, navigators and bombardiers and training tailored to these tasks. In addition, Flanagan and his contemporaries revolutionised the field of psychological and aptitude testing by developing job selection models which restricted training to those candidates with a high probability of completing training courses. Use of these models allowed the placement of individuals in jobs suited to their abilities (21:207).

This work stimulated vast quantities of research after the war and the concepts of individual learning differences, the use of media such as audio-visual techniques and simulators as learning aids, and the relationship between behavioural science and learning theory provided a framework for a systems approach to education and training (16:20). In their book *Principles of Instructional Design* (16), Briggs and Gagné cite Davies, who described the systems approach to education as "an outgrowth of a number of converging influences upon practices in instruction," and include references to Pressey, Briggs, Skinner, Kaufman and military researchers (presumably Flanagan and his contemporaries) among those influences (16:20).

Kaufman believes that a systems approach to the planning, design, and implementation of an effective learning system should follow these steps:

1. Identification of priority needs and associated problems.

2. Determining requirements to solve the problem and identifying possible solution alternatives for meeting the specified needs.

3. Selecting solution strategies and tools from alternatives.

4. Implementing solution strategies, including the management and control of selected strategies and tools.

5. Evaluation of performance effectiveness based on the needs and requirements previously identified.

6. Revision of any or all previous steps to ensure that the educational system is responsive, effective and efficient. (20:12)

The ISD process appears to conform to this model.

The Instructional Systems Development Process

The term Instructional Systems Development (ISD) does not appear to be attributable to any one particular research effort. Briggs and Gagné use the term in a generic sense, describing instructional design which produces educational systems that concentrate on "the individual learner's activities and the testing of their outcomes" (16:20).

USAF sponsored research into training system development, initiated in the late 1960s, culminated in the publication of numerous works on instructional systems including Schumacher and Glasgow, *Handbook for Designers of Instructional Systems* (41). This work has evolved into the six volume Air Force Publication (AFP) 50-58, which describes a five-step Instructional System Development model (9).

Kulps and Childs report reviewing a collation of almost 3000 abstracts on instructional systems in a 1975 study to develop training programs for the Bell Systems of the American Telephone and Telegraph Company (AT&T) (24:36). Their resulting approach employed the first three steps of the ISD model which was assessed as more useful than contemporary means of curriculum development, "which are devoted to education; to prepare students for life and living," rather than "training people to perform a definable job" (24:36).

Much of the more recent literature suffers from this same emphasis, education in terms of the school system for teaching children and adolescents rather than adult training for vocational employment. Kaufman contends that both involve behaviour change and the same basic philosophies, and that both can use the same instructional design strategies (21:206). Nevertheless, nothing of consequence could be found in the literature to dispute the philosophy behind the ISD model.

ISD combines the theoretical concepts of training and human behaviour with job requirements which require training to obtain "cost effective instruction that produces graduates who can do the job" (10:8). The use of ISD has produced consistent gains in efficiency of instruction in a wide range of subject areas to the extent that Air Force Regulation 50-8 now directs the use of the ISD process for the management of training programs throughout the USAF (10:8).

The USAF ISD Model

The ISD process is defined by the Department of The Air Force in Air Force Manual (AFM) 50-2 as

> A deliberate and orderly, but flexible process for planning and developing instructional programs which ensure that personnel are taught the knowledges, skills, and attitudes essential for successful job performance. (10:74)

The five-step ISD model may be summarised as follows:

1. Analyse System Requirements. Determine the human performance requirements of the job and state in terms of the skills, knowledge and attitudes necessary to perform tasks to meet those requirements.

2. Define Education/Training Requirements. Determine the skills, knowledge and attitudes which must be taught to equip an

individual to perform the tasks identified in step one. In addition, determine resource requirements and availability for such training.

3. Develop Objectives and Tests. Specify the objectives which an individual must meet to satisfy the training requirements identified in step 2 and develop criterion-referenced tests which directly measure student attainment of those objectives. The Bloom, Krathwohl, and similar taxonomies define prescribed behaviour to test student achievement.

4. Plan, Develop and Validate Instruction. Select training methodology and media to impart the required knowledge, skills and attitudes, and develop the instructional materials and notes. Results of this step should be tested and validated to ensure objectives of training can be met and any deficiencies rectified before the next cycle begins.

5. Conduct and Evaluate Instruction. Provide the training planned in step 4 and administer tests developed in step 3. Evaluation also involves determining the extent to which graduates satisfy the job requirements of the working environment. Such evaluation must be performed by individuals other than the course designers, and feedback must be provided in order to complete the cycle (10:10-52; 9:Vol I 1-3).

The model is depicted in Figure 3 and the process is expanded in detail in the six volumes of AFP 50-58.

The model is flexible; the process can be initiated at any step depending on the requirements of the system. For example, acquisition

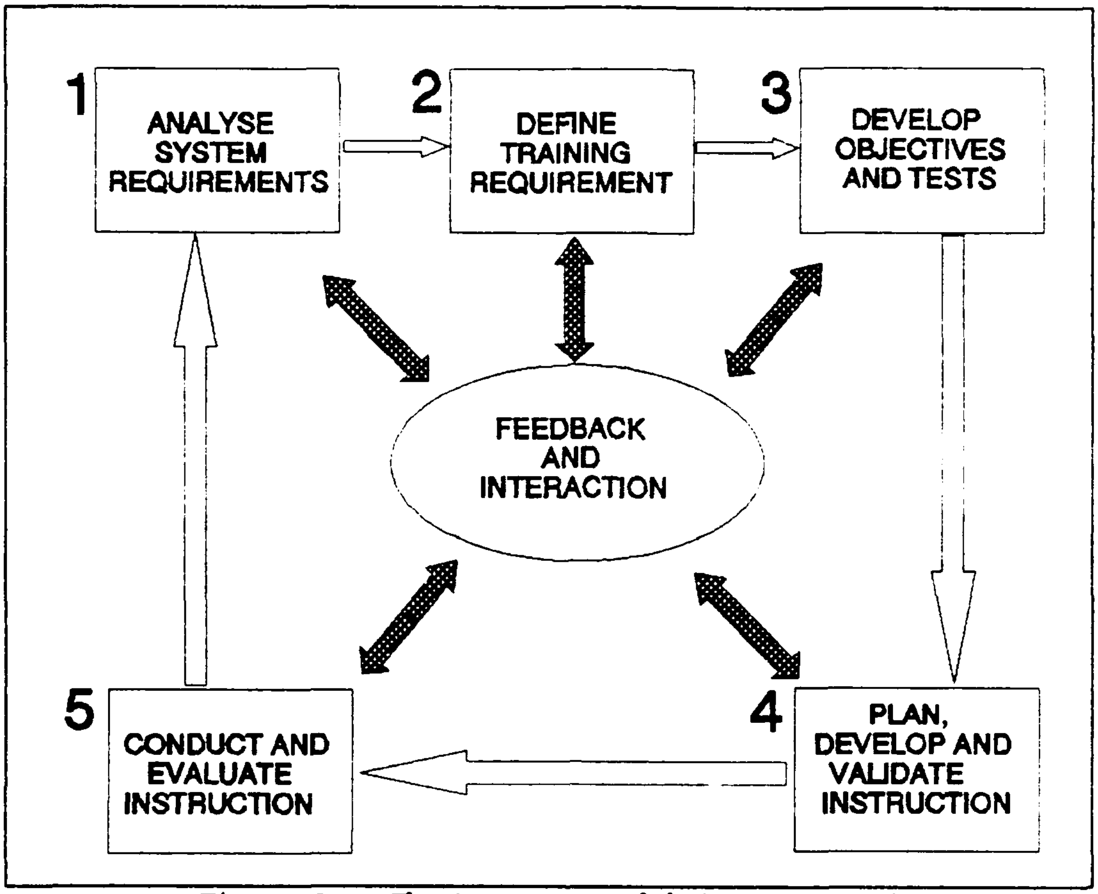

Figure 3. The USAF ISD Model (8:1-2, 10:4)

of a new weapons system will require beginning at step 1 and performing all subsequent steps. A change in Air Force training policy will necessitate performing step 2 to redefine training requirements for existing programs but not the redefinition of job requirements.

AFM 50-2 states that Air Force policy requires the ISD process to be used to plan, develop, and manage new instructional systems (10:7). However, of particular interest for this research, the manual also provides guidance in using ISD to revise existing programs. In addition, the process is self evaluating if carried out correctly as step 5 involves both conduct and evaluation of training. Evaluation in this context is defined as:

a procedure to determine the effectiveness of the performance of an instructional product or process in order to ascertain specific causes for the effectiveness or lack of it, and to make decisions appropriate to the extent of the effectiveness. Evaluation of formal courses includes field evaluation and internal evaluation. (10:73)

Field evaluation is defined as:

the acquisition and analysis of data from outside the formal training environment to evaluate the training product in the operating environment. (10:73)

Internal evaluation is:

the acquisition and analysis of internal feedback and management data from within the formal training environment to assess the effectiveness of the training process. (10:73)

The ISD Model - A Basis For Evaluation of RAAF Navigator Training

The full ISD process allows for the development of complete instructional systems and the resultant curriculum is described by a syllabus or individual syllabi for component subjects. A curriculum (or syllabus) should begin with a statement of aims and objectives for the training, provide a breakdown of content to achieve those aims, imply or state patterns of learning and teaching of content, and explain how course outcomes will be evaluated (24:37).

As previously mentioned, Kulp and Childs used an ISD approach in successfully developing curricula for the Bell Systems of AT&T in the 1970s although this was only a partial application, consisting of three of the five steps. It seems reasonable to deduce that if ISD can be used to produce a system which will be described in whole or part by a curriculum, ISD can also be used to evaluate a curriculum which describes an educational system, such as the RAAF Basic Navigator Course. Steps 1, 2, 3 and the evaluation process in step 5 of the ISD process would appear to provide a framework for a study of RAAF

navigator training. Step 4, while crucial to the design of courses using ISD, does not appear to be necessary in the evaluation of an existing program and even if it were to be performed, it is not feasible given the separation of the researcher from the site of instruction and required research data.

Summary

The field of education and training has generated a great deal of research, much of which has been driven by the US military in an effort to maximize training effectiveness at least cost. This chapter presented a summary of the basic theories which have been proposed to explain learning and examined the ISD approach to training which has evolved over tne last thirty years.

While much of the current literature on training does not refer to the process by name, many of the contemporary texts on instructional systems employ the same theories and philosophies as ISD. The USAF experience with ISD has been so successful that AFR 50-8 now directs its use for management and design of all USAF training programs. Given that success, the ISD appears to provide a sound theoretical framework for the evaluation of RAAF navigator training proposed by this thesis.

IV. Methodology

Chapter III presented a brief review of theories in education and training as background for a discussion on the ISD process for training development and design. The chapter concluded that this process could be adapted to provide a framework for the evaluation of RAAF navigator training, a partial answer to investigative question 8 posed in Chapter I. This chapter describes the steps taken to provide data for that evaluation and the methodology chosen to answer the remaining investigative questions.

Evaluation Type

This thesis most closely represents a field evaluation of the RAAF Navigator Course according to the definition given in Chapter III. The survey data to be used for the evaluation was obtained from navigators and supervisors in operational squadrons and the training products are those graduates from SAN who have not yet completed conversion training.

While crucial to a complete evaluation, a complete internal evaluation was not considered feasible for this thesis, given the analysis required of data available only at SAN or Headquarters Training Command in Australia. The use of training policy documents and the syllabus of training as data constitutes a partial internal evaluation of navigator training, but time and manpower did not allow for the provision of resources to collate and analyse training reports, student critiques, test results and other sources of feedback in order to provide other necessary data. However, SAN has been tasked by Headquarters Training Command to carry out an internal evaluation of the

RAAF Navigator Course (30) and a follow up study may be necessary depending on the findings of that evaluation.

RAAF Training Policy

Before examining the syllabus of training for the RAAF navigator course, it is necessary to examine the RAAF training policy contained in Defence Instruction (Air Force) 2002.012, the RAAF Manual of Training Policy and Procedures, and to compare the training philosophy therein to that underlying the ISD process This comparison is necessary to ascertain if there are any significant differences in training philosophy between the RAAF and the USAF which would invalidate use of the ISD process as a basis for evaluation.

Aim of RAAF Training. The manual states that the aim of RAAF training is to

> provide every member of the RAAF with the necessary knowledge, skills and attitudes to enable him to be an effective member of the RAAF workforce, within his designated category or mustering. (37:1.1)

That aim matches closely with the definition of the ISD process from Air Force Manual (AFM) 50-2 provided in Chapter III;

> A deliberate and orderly, but flexible process for planning and developing instructional programs which ensure that personnel are taught the knowledges, skills, and attitudes essential for successful job performance. (10:74)

The underlined phrases in these definitions show a striking similarity which suggests that an ISD approach to RAAF training is certainly compatible with the aim of such training.

RAAF Training Principles. The RAAF Manual of Training Policy and Procedures provides a list of training principles commensurate with the aim of RAAD training which include:

a. Training is to be task orientated, and directed towards the development of appropriate knowledge, skills and attitudes.

b. Training objectives are to be derived from job requirements as determined by an appropriate method of Occupational Analysis.

c. Training proficiency levels are to be determined by the needs of immediate post training employment or subsequent training pre-requisites.

d. Essential tasks performed during an emergency should be included in the training.

e. Training should be restricted to those tasks commonly performed in the immediate post-course employment, and

f. Training courses are to be regularly evaluated. (37:1-1 to 1-2)

The manual emphasises that these training principles provide the policy to ensure that RAAF training programs meet the aim and that training is as effective and efficient as possible (37:1-3). This philosophy is mirrored in AFM 50-2 which describes ISD as "an instructional design model for developing and conducting efficient and cost-effective instructional systems" (10:1).

Similarities in training philosophy between the RAAF and the USAF continue. The central theme of ISD is one of student-centered learning where emphasis is placed on learning in terms of behavioural outcomes rather than instructor activity and those outcomes are measurable in terms of meeting objectives as opposed to performance on tests relative to other students. Paragraph 805 of the RAAF manual states that testing is used on RAAF courses to "assess student achievement of training objectives" and paragraph 806 describes achievement tests in terms of "specific objectives against laid-down proficiency levels" (37:8-1).

The manual provides a list of "performance words" which describe the practical or cognitive skill required of the student in meeting

training objectives; part of that list is reproduced in Appendix D. There is a direct relationship between the list and the Bloom taxonomy described in Chapter III: they possess the same hierarchy. In addition, measurement standards, the codes described in Appendix C, form the basis for defining the degree of learning required for particular Syllabus Objectives. The manual directs that a training objective must begin with a statement describing the task to be performed, specify necessary conditions, and conclude with the standard required (37:4-1). Chapter 4 of AFM 50-2 states that all objectives should describe behaviour, conditions, and standards (10:23).

Answers to Investigative Questions Seven and Eight

From the brief comparison above, it is evident that the RAAF and USAF share the same basic philosophies with regard to training. These philosophies appear to be well grounded in the educational theories described in Chapter III, and therefore an affirmative answer to investigative question 7 would appear justified. It follows that use of the ISD as a framework for evaluation of RAAF navigator training is a valid approach in terms of the issues raised in Chapter I.

Scope Of ISD Approach To This Research

While a complete ISD analysis may be desirable, such an analysis is not possible within the constraints of this thesis given the amount of data, depth of analysis, and the expertise required for such an approach. A modified approach was therefore developed which provides a means to obtain the answers to the remaining investigative questions posed in Chapter I. That approach is described in the following paragraphs.

Step 1 - Analysis of System Requirements

AFP 50-58 describes the Air Force Occupational Survey as the primary source of data for Step 1 of the ISD process (9:Vol II, 2-3). Fortunately, the RAAF has published three occupational analyses of its non-pilot, officer aircrew categories in recent years, 1975, 1981, and 1988. Only two were available for this research: a restriction was placed on release of the 1981 report. The 1975 report provided the results of a survey administered to 131 Navigators and 79 Air Electronics Officers in 1974 (26), and the analysis published in May 1988 pertains to survey data collected from 98 operational navigators during 1986 and early 1987 (28).

The data from the 1974 survey is in the form of time spent in each task, which is difficult to correlate to the 1987 data. In addition, the changes to aircraft inventory and role since 1974 make much of the data dated and irrelevant. The stated purpose of the 1988 study was to collect occupational data which identified the tasks performed by operational navigators and to present that data in a format suitable for assessing the validity of current basic training with respect to Course Terminal Objectives and Job Requirements (28:1). As that assessment is the aim of this thesis, the results of the 1988 survey appear to provide a perfect source of data for the purpose. Given the difficulties and costs associated with survey administration, particularly in light of the distance between researcher and target population, the development of a separate instrument for this thesis was not considered to be warranted.

Therefore, for the purposes of this research, only the 1988 study was analysed in detail. The study was based on a survey administered to

all navigators in 1979, notwithstanding the restriction, and reports similar results with no appreciable change in respondent attitude (28:20). The data therefore appears to possess both reliability and validity. In addition, the aircraft and roles requiring graduates from basic navigator training have not changed significantly in that time, and the data is more current.

Collection and Treatment of Survey Data. It is appropriate at this point to summarise the collection and treatment of the primary data which led to the 1988 report. Responsibility for Occupational Analysis for the RAAF rests with the Occupational Analysis Section, GT3A, formerly a part of Headquarters Support Command, but now an organisation within RAAF Training Command and responsible to the Staff Officer General Training (SOGT). The RAAF employs the Task Inventory method of Occupational Analysis based on the USAF method to collect occupational data described in AFR 35-2 (11). Responses about jobs are gained directly from the incumbent which results in accurate and reliable data (28:1-2).

The survey instrument, developed by GT3A, was modelled on that used in 1979 and contained a background section and a task inventory of 481 tasks performed by navigators. Background information including questions about rank, time in category, current role, job satisfaction, and subjective thoughts on training was chosen on the basis of the objectives of the survey and was not subject to pre-testing (28:2).

The task inventory was formulated from previous surveys, the syllabuses of training for the basic navigator and squadron conversion courses, and input from Subject Matter Experts (SME): two senior

navigators in staff appointments at HQSC. This section was evaluated by pre-test on navigator instructors at SAN and senior navigators at the operational squadrons and was amended before release to navigators in the field (28:2-3), further reinforcing the validity of the data obtained. The task inventory from the survey instrument is included at Appendix A.

Primary Data Analysis. The original survey data was analysed by GT3A using the Comprehensive Occupational Data Analysis Programs (CODAP), a software package developed by the USAF for occupational analysis, and made available for RAAF use. Information on CODAP can be obtained from the USAF Occupational Measurement Center at Randolph AFB or from RAAF Training Command (GT3), RAAF Point Cook. The CODAP analysis of survey data was run on a UNISYS 1100 TM mainframe computer and utilised a job clustering algorithm which compared each respondent's answers for respective inventory items with those of all others to obtain a composite job group of like respondents. This group was based on the actual tasks performed and time spent on each task. In an iterative process which cross referenced each task between respondents, a series of job groups was formed. These were then linked by common tasks to sub-clusters and these to one general job cluster containing all 98 respondents.

Survey Administration. As previously stated, the purpose of the survey was to obtain data from operational navigators, and therefore the target population was RAAF navigators in operational flying duties. That population represented 152 navigators below the rank of Wing Commander (LTCOL equivalent), and questionnaires were mailed to each of these individuals in November 1986 for return by mid-December.

While driven by a desire to collect data prior to end-of-year postings (assignments) which were likely to affect some of the population, the survey administrators neglected to account for the fact that many of the population were employed in roles requiring lengthy absences from home base. The time allowed may therefore have affected the response rate which was initially disappointing. Notwithstanding an extension to the close date, follow up action was delayed and although additional booklets were mailed in April 1987, only 98 responses were received. This represented a response rate of 65 percent, well below the 91 percent response rate for the 1979 survey which targeted all 323 navigators in the RAAF at that time (28:20). Nevertheless, the similarity in results reported between both studies indicates that the 1987 data is consistent with that obtained from a statistically more reliable source and is therefore, by inference, reliable.

Refinement of Data for Thesis Purposes. Data from the 1988 report provided a task inventory of 481 tasks performed by operational navigators. Full Job Performance Requirements (JPRs) as specified in the ISD documentation were not considered necessary as the purpose of this study was to evaluate existing instruction, not write new training requirements and objectives from the survey data. Therefore, the 481 tasks were not subdivided into sub-tasks as would normally be the case if JPRs were to be determined.

The author of the 1988 report separated tasks requiring initial training and those suited to conversion courses or OJT on the basis of rank of the respondent as a first step. His rationale was that initial training provided to equip personnel to perform tasks that will not be performed regularly in the first 24 months of operational flying will

require re-training as the effects of training are lost if not reinforced (28:16). That position is an application of the extinction theory of Luthans and Kreitner, as reported by Rowe: responses that are not reinforced (such as by practice) will decrease in frequency and eventually disappear (36:25).

Most SAN trainees are commissioned as Pilot Officers (PLTOFFs) (Second Lieutenants) on graduation. Therefore, tasks identified by PLTOFF navigators on the task inventory correspond to those tasks performed in the first 24 months of operational flying. There were 22 respondents in this category. However, some trainees graduate from SAN as Flying Officers (FLGOFFs)(Second Lieutenants) and the data does not separate those officers from FLGOFFs with more than 24 months experience. Therefore, to take account of this factor, and to increase the size of the sample for greater statistical reliability, the responses from both PLTOFFs and FLGOFFs (representing 43 respondents) were broken out into a separate sub-group. That data, a listing of 467 of the original 481 tasks with associated statistics, was then further analysed in this thesis.

Only one FLGOFF respondent was employed in duties usually performed by more senior navigators and as these duties were specific to P3 aircraft, the tasks attributed to his responses should be eliminated in the next step (assuming accurate coding of responses). This step involved deleting all tasks which were not common to all aircraft types; such tasks are better trained on squadron conversion courses. Examples of such tasks from the inventory at Appendix A included "operate AQS-901" (found only on P3 aircraft), "monitor TFR radar" (restricted to F-111 navigators) and "use gyro-grid techniques" (a technique employed on

C-130 aircraft). In addition, tasks of a trivial nature such as preparation of in-flight meals and refreshments, loading and un-loading of luggage and mission documents, and arranging transportation and accommodation were also deleted. Any training required for such tasks can easily be provided by on-the-job instruction and does not warrant formal training at SAN.

These steps therefore reduced the original inventory of 481 tasks to a list of 139 tasks which were then analysed in accordance with the methodology described by Step 2.

Step 2 - Definition of Education/Training Requirements

In keeping with the ISD framework, the second stage of the methodology involved identifying training requirements for those tasks from the modified job inventory that require centralised instruction. The design of the survey instrument incorporated factors to facilitate such analysis as respondents were asked to rate all tasks in the inventory on Training Emphasis (TE) and Training Difficulty (TD) on a comparative basis.

Training Emphasis. Each task was rated on a nine point scale with 1 equating to little or no structured training required and 9 corresponding to extremely heavy structured training necessary when compared to the other tasks in the inventory. These ratings were then adjusted so that tasks of average training emphasis had a rating of 5 with a Standard Deviation (SD) of 1 (28:4).

Task Difficulty. A ten point scale was provided for the respondent to rate Task Difficulty with 0 corresponding to

no knowledge of the task, 1 representing a task extremely easy to learn with little time required to acquire, and 9 equating to a task which is extremely difficult to learn and takes a great amount of time to acquire. A similar adjustment process to the TE rating was then employed to yield a rating of 5 (SD 1) for tasks of average difficulty when rated to all tasks in the inventory (28:4).

Determination of Essential versus Desirable Training Requirements. AFM 50-2 notes that when a task is performed by about half of the job holders, the decision to include or exclude training is dependent on other factors, and a "best judgement" decision may be necessary that includes both the Percent Members Performing (PMP) a given task and the criticality of that task to mission success or flight safety as factors (10:16). The USAF Occupational Measurement Center, located at Randolph Air Force Base, employs a more scientific approach by separating CODAP generated data according to a decision training matrix published in AFR 35-2 (11). Table 1 is adapted from that matrix.

Whereas USAF occupational analysts separate PMP factors into 3 categories, greater than or equal to 50 percent, 30-49 percent, and less than 30 percent, RAAF analysts employ two categories with the cut off at 30 percent. RAAF training specialists consider initial training by way of a formal course, such as the RAAF Basic Navigator Course, essential for (although not restricted to) tasks with PMP greater than 30 and TE greater than or equal to 6.0 (28:16). Training for tasks with PMP greater than 30 and TE and/or TD greater than 4.0 is considered to be desirable but a decision must be made as to whether training should be on an initial course or by way of conversion training and On-The-Job Training (OJT) (28:16).

Table 1

USAF Training Decision Matrix

OCCUPATIONAL SURVEY DATA			SAFETY/ CRITICAL TASK	TRAINING DECISION
PMP	TE	TD		TRAINING PROVIDED
50 - 100	≥ 6	≥ 3	Yes/No	Task Knowledge and Performance
50 - 100	≥ 6	< 3	Yes	Task Knowledge and Performance
50 - 100	≥ 6	< 3	No	OJT
50 - 100	5 - 5.59	≥ 3	Yes/No	Task Knowledge and Performance
50 - 100	5 - 5.99	< 3	No	OJT
50 - 100	< 5	≥ 3	Yes/No	Task Knowledge and Performance
50 - 100	< 5	< 3	No	OJT
30 - 49	≥ 6	≥ 3	Yes/No	Task Knowledge and Performance
30 - 49	≥ 6	< 3	Yes	Task Knowledge and Performance
30 - 49	≥ 6	< 3	No	OJT
30 - 49	5 - 5.99	≥ 3	Yes/No	Task Knowledge Only
30 - 49	5 - 5.99	< 3	No	OJT
30 - 49	< 5	≥ 3	Yes/No	Task Knowledge Only
30 - 49	< 5	< 3	No	OJT
≤ 29	≥ 6	≥ 3	Yes	Task Knowledge Only
≤ 29	≥ 6	≥ 3	No	OJT
≤ 29	< 6	< 3	Yes/No	OJT

(11)

The rationale for the RAAF approach is that USAF personnel are trained for specific tasks within a particular specialty, while the small size of the RAAF and the constraints on manpower require a broader skill level to allow for greater flexibility in manning (17). While this rationale seems reasonable, there is no empirical evidence available that validates the approach taken, and this factor may well be an area for further research by RAAF training specialists.

Nevertheless, for the purposes of this study, the only practical difference between the two approaches is that the USAF matrix allows a decision as to whether a task should be trained for knowledge and performance capability, or knowledge only, for those tasks performed by between 30 and 49 PMP. While the RAAF provides both task knowledge and performance training for tasks with PMP greater than or equal to 30, and high TE and TD (greater than 6 and 4 respectively), the USAF would restrict tasks with TD less than 3 to knowledge only for tasks with PMP between 30 and 49.

For simplicity, tasks identified in step 1 were classified in terms of essential as opposed to desirable rather than knowledge and performance opposed to knowledge only. At SAN, task learning occurs in three environments: the classroom (which includes preparatory reading in a library or study), the simulator, and the training aircraft. Task knowledge is provided in the classroom and realistic task performance is refined and practiced in the simulator before being applied and examined in the air. This study is not concerned with which environment or training media is best suited for each task, but rather that the task is taught at all. The most effective combination of the three training

environments may well warrant further study but is beyond the scope of this thesis.

Therefore, those tasks meeting the criteria for "task knowledge and performance" as defined in Table 1 were classified as those tasks essential for training in the Navigator Course. A subjective assessment, based on the author's own experience as an instructor at SAN, was made for tasks which failed to meet the criteria on this basis but which are critical to safety or are pre-requisite knowledge for essential tasks. Tasks meeting "task knowledge only" criteria were classified as desirable for basic training and those remaining were classified as more suitable for on-the-job (OJT) or conversion training.

To this point, the methodology has followed the ISD process fairly closely, although not in as much detail as required for course design. It has, however, provided data which answers investigative questions 1 and 3 and that discussion is presented in Chapter V. In its usual form, ISD continues with the formulation of JPRs which form the basis for developing objectives and tests in Step 3, and specifying necessary levels of knowledge, skills and proficiency levels for each task to be trained. However, syllabus objectives for the RAAF Navigator Course exist and an alternative Step 3 was therefore developed.

Step 3 - Aligning Training Requirements with Syllabus Objectives

This step first involved a comparison of the training tasks identified as essential or desirable as a result of Steps 1 and 2, with the Course Terminal Objectives (CTOs) contained in Annex A to Section 1 and the Syllabus Objectives in Section 3 of the Syllabus of Air Training

Navigator. However, some difficulties were encountered in relating syllabus objectives directly to the survey data.

In the first instance, the Course Terminal Objectives and the objectives stated for individual flights were too general to relate to specific tasks in the inventory. This was not a major obstacle as syllabus objectives in the ground training section were much less general and all of the tasks performed in the air are first taught on the ground. The stated objectives for each block in the syllabus for Air Navigation also included the simulator exercises prior to each flight which mirrored the objectives of that flight, thereby allowing the matching of all tasks from the reduced inventory with corresponding Syllabus Objectives.

Each Syllabus Objective was examined in turn and classified as directly meeting an essential training requirement (METR), directly meeting a desirable training requirement (MDTR), defining essential pre-requisite knowledge (KNOLE), defining desirable pre-requisite knowledge (KNOLD), and other (OTHER). An assumption was also made that the ability to explain or state a procedure (objectives using this or similar wording were classified as defining knowledge rather than task performance) implied an ability to perform a procedural task.

In other words, METR identifies an objective that met an essential requirement directly. "Calculate Point of Safe Diversion (PSD) by graphical methods" (39:3-27) is one such example. MDTR corresponds to an objective that meets a desirable requirement directly. KNOLE identifies an objective which provides knowledge related to essential task performance. For example, "Explain how to carry out a sector search and a creeping line ahead search" (39:3-30) trains for task A37,

determine search patterns. KNOLD relates to an objective which provides knowledge related to desirable task performance. Objectives classified OTHER were then compared with tasks from the job inventory which were classified OJT to determine if any overlap between initial and conversion courses could be identified. The complete process provided an answer to investigative question 2.

In addition, the wording of representative CTOs and Syllabus Objectives, and the attainment levels quoted therein, were examined in light of guidance and direction contained in AFM 50-2 and AFP 50-58, and the policy contained in Defence Instruction (Air Force) AAP 2002.001, Manual of Training Policy and Procedures (RAAF) (37) to determine answers for investigative questions 4, 5 and 6. Given that RAAF syllabus structure is standardised by direction from Chapter 7 of the policy manual, an analysis of each stated objective was unnecessary. Examples were therefore drawn from the core subject of the course, Air Navigation, and the Course Terminal Objectives for the Air Training Phase, these being the major components of the course and displaying representative objective characteristics.

Step 4 - Assessing Student Evaluation

The final step involved an investigation of student evaluation methods described in the syllabus. As mentioned in Chapter I, a proposed amendment to the syllabus was received after this research was initiated which made major modifications to the syllabus, particularly in the flying phases of the course and evaluation of student performance in those phases. The changes are presently being trialled at SAN, and therefore this aspect of the course can be evaluated only after the

present class of students has completed training. A theoretical discussion is therefore provided.

Evaluation also includes the extent to which graduates are able to perform the job requirements after training, and for the same reason as above, a planned telephone survey of squadron executives to gather feedback type data was not warranted at this time. Such a study should be initiated after graduates of the present course have completed conversion training, at this stage mid 1991.

Summary

This chapter outlined a four-step methodology, based on the USAF ISD model, which was employed to evaluate the syllabus of instruction for the RAAF Basic Navigator Course. The steps were:

Step 1 - Analysis of System Requirements;

Step 2 - Definition of Education/Training Requirements;

Step 3 - Aligning Training Requirements with Syllabus Objectives; and

Step 4 - Assessing Student Evaluation.

The results of the evaluation are provided in Chapter V.

V. Presentation and Discussion of Results

Chapter III concluded that the ISD process appears to provide a sound theoretical framework for an evaluation of RAAF navigator training. In order to confirm that conclusion, an answer was also required for investigative question 7. That discussion was contained in Chapter IV. The methodology described in Chapter IV was then employed to seek answers to the remaining investigative questions posed in Chapter I, and the findings are presented in this chapter.

Statistical Correlation

While the original survey data was not available to the researcher for statistical analysis, the 1988 report quotes correlations of .91 for TE ratings and .97 for TD ratings. These are very high levels of agreement amongst respondents as to those tasks requiring structured training as opposed to those which do not, and those tasks which were difficult to learn when compared to those which were not (28:16). The report does not indicate which correlation coefficients these factors represent; further investigation revealed that they are Spearman-Brown coefficients corrected to n = 40 (18). High Spearman-Brown coefficients indicate reliable measurement data (14:269), and the quoted similarity in results between the 1988 and 1981 reports also lends validity to the data. The raw data was not available to verify these figures.

Bias due to P3C Navigators

There is evidence of some bias in PMP data due to responses from P3C navigators employed in both navigation and tactical co-ordinator or

sensor operator duties. This is obvious from data which shows 100% of navigators on C130 and F-111 aircraft performing tasks such as preparation and submission of flight plans as opposed to 77.4% of PLTOFF/FLGOFF navigators on P3C aircraft, and 100% of non-P3C PLTOFF/FLGOFF navigators establishing position from Inertial/Omega/Air Data Computer opposed to 87% for P3C respondents of the same rank. All respondents in this sub-group would be expected to perform these tasks.

There are other such irregularities throughout the inventory. However, the differences between the actual percentage of P3C navigators performing tasks where 100% would be expected, and 100%, are not constant. The most likely explanation is that of the 23 PLTOFF/FLGOFF navigators from the maritime squadrons who returned surveys, eight were primarily employed as sensor operators or tactical co-ordinators. Some, if not all may have also performed navigator duties on occasions and answered the survey accordingly. The survey instructions did not take this factor into account and it also appears to have been overlooked in the original analysis.

In addition, the high number of PLTOFF/FLGOFF respondents from the maritime squadrons as a function of all PLTOFF/FLGOFF respondents (23 out of 43 or 53.4%) also biases PMP results towards maritime navigators as opposed to navigators overall. The format of the data received for this research did not provide adequate means to allow statistical adjustments to be made to correct for either of these effects although the latter was reduced by deleting all tasks which were not common to all aircraft. In the interests of accuracy, such statistical adjustment was certainly desirable but not feasible under the circumstances.

In any event, the results as they stand after steps one and two of the methodology are considered adequate for the purposes of this study given the range of the PMP values in Table 1 on which training decisions were made. For tasks in Appendix E with PMP values less than 50, some tasks which might have otherwise been classified essential may be classified as desirable, and some tasks classified OJT may in fact be desirable for tasks with PMP less than 30. Given the overall scope of the analysis, these differences are insignificant.

<u>Question 1</u>

Which of the fundamental responsibilities of a RAAF Navigator, as identified by the 1988 survey, require essential training at SAN and which are merely desirable?

Application of steps one and two of the methodology produced the list of tasks contained in Appendix E. These tasks are ranked as essential, desirable, and OJT in descending order of Percent Members Performing (PMP) by PLTOFF/FLGOFF navigators within each of the three categories. The results warrant some discussion.

Annex E-1 to the 1988 report listed 35 tasks performed by PLTOFF/FLGOFF navigators which met the RAAF criteria for essential training on a basic course. Appendix E lists 89 such tasks. Given the more liberal TD criteria of the current methodology, and the inclusion of safety related and critical tasks under the matrix in Table 1, this result is not surprising. In addition, 32 tasks were classified as desirable for inclusion in the basic navigator course, and the remaining 18 as OJT in the current study. The 1988 study did not report desirable or essential tasks.

There are some surprises in the tasks identified as essential, considering the discussion on the impact of technology on navigator duties in Chapter II. 76.7% of PLTOFF/FLGOFF navigators (and 51% of all respondents) reported that they used celestial techniques to establish aircraft position (task B192). Use of celestial navigation was common to all aircraft types except F-111C and it accounted for 0.59% of relative time spent (RTS) on in-flight tasks by all navigators, a relatively high proportion compared to other tasks in the inventory (monitor communications rated 1.14 and establish aircraft position using navigational systems rated 1.09). The median value for RTS was 0.13%, and only 25% of all tasks in the inventory had an RTS value of 0.29% or greater.

It is not clear from the data whether the requirement for celestial navigation stems from squadron directives for navigators to keep current at the task or is required for actual navigation purposes due to failure of automatic equipment or non-availability of other fixing methods. Nevertheless, to comply with ISD methodology, and the OA decision matrix criteria, there is still a need to train for the task at basic level. The latest SAN amendment to the syllabus reduced the amount of t.aining in celestial navigation from previous courses and probably represents a reasonable balance. However, more research is required to address this point and to ascertain if celestial navigation is still a technique which should be taught at SAN.

Another interesting result was the proportion of respondents who established position by dead-reckoning means (DR) (49% of all respondents, 67.4% of PLTOFF/FLGOFFs). All C-130 navigators employed this technique as did some F-111 and P3 navigators; these aircraft all

possess at least one alternative automatic system in addition to an Inertial or Omega system. Again the task represented a reasonable proportion of relative time spent (RTS), 0.76%.

There are good reasons for navigators to maintain currency at DR navigation. The most obvious is the requirement to continue to navigate should automatic systems fail or sustain combat damage. Therefore, notwithstanding technology, and the use of automatic equipment (Inertial/Omega/Air Data Computer) by 100% of respondents (taking into account bias in the data due to P3C navigators in sensor operator duties), there is still a need to train DR navigation at SAN on the basis of the survey data. An argument could also be made for teaching the technique on the basis of pre-requisite knowledge. The knowledge required to perform dead-reckoning is fundamental to the understanding of navigation principles, and asking a student to perform DR constitutes a valid evaluation method to test this knowledge at the higher levels of the Bloom taxonomy. The question then becomes one of emphasis and this aspect will be covered in later discussion.

Question 2

Are the responsibilities of a RAAF navigator which require training, adequately reflected in the course objectives as defined by the syllabus of training?

Step three of the methodology described the general process employed to seek an answer to this question, and Table 2 provides a summary of results. An important point in interpreting these results is that the majority of tasks listed in the task inventory are major tasks

(although some sub-tasks are also listed). The Syllabus Objectives represent training objectives for tasks which may be sub-tasks of others, and some objectives provide knowledge which may be required for both essential and desirable tasks.

Table 2

Number of Training Objectives Identified By Category

Subject	METR	MDTR	KNOLE	KNOLD	OTHER
Airmanship	5	1	23	16	1
Air Navigation	33	2	80	7	5
Air Traffic Control	2	1	28	12	
Astro (Celestial)	9	1	17	1	
Communications Procedures	3	1	32		
Communications Security	1	1	2		2
Electronic Nav Aids	5	2	10	10	3

NOTES: METR = Objective that met an essential requirement.
MDTR = Objective that met a desirable requirement.
KNOLE = Objective which provided knowledge related to essential task performance.
KNOLD = Objectives which provided knowledge for desirable task performance.

In such instances, the objectives were classified at the highest applicable level. For these reasons, Syllabus Objectives may relate to more than one task, and one task may require more than one objective to define the training requirement.

Many of the syllabus objectives were stated in terms of providing knowledge, with few directly describing task performance. However, task performance ability can be applied with knowledge such that new tasks

are able to be performed without specific instruction. In other words, training for a particular task is transferred with other knowledge into an ability to perform tasks that have not been specifically trained.

The most significant finding was that training objectives for all of the tasks identified as essential or desirable for training in the preceding steps were found in the Syllabus Objectives. In addition, such objectives were all contained in the syllabus objectives for seven of the 21 subjects covered in the Ground Training section of the course; Airmanship, Air Navigation, Air Traffic Control, Astro (Celestial Navigation), Electronic Navigation Aids, Communications Procedures and Communications Security. Therefore, the short answer to question two is yes, the responsibilities of a RAAF navigator which require training are adequately reflected in the course objectives as defined by the syllabus of training. The fact that they were all taught in seven subjects of the course will be expanded on in the answer to question 3.

Question 3

Is there any material contained in the syllabus which may be considered redundant, or which is better taught during squadron conversion?

Step 3 of the methodology also provided the information to answer this question. Seven of the 16 tasks classified OJT were also covered by instruction in the seven subjects listed above. They are: obtain time check, page check cryptographic material, assess ground based communications, install Verey pistol, operate TACAN, rectify minor faults, and return cryptographic material to custodian. None of these tasks require substantial training effort (as evidenced by their low TD

ratings - Appendix E), and all could be classified as sub-tasks of other essential or desirable tasks in the inventory. Therefore, training for these tasks at SAN is appropriate.

The remaining 9 tasks classified OJT by the analysis could not be clearly identified in any of the syllabus objectives. These were: arrange for diplomatic/overflight clearances, co-ordinate survival pack drops, gather met data, monitor OAT (Outside Air Temperature) indicator, file log and charts, reconcile ES4 (a RAAF administrative form) and flight advance, submit completed sortie records, perform period review of flight manuals, and report anomalies in Flight Information Publications (FLIP) to the Aeronautical Information Service.

Instructions for arranging diplomatic/over-flight clearances are readily available at the operational squadrons and are easily learned by performing the task with reference to these instructions; the task does not need to be trained at SAN. The design of the HS748 does not allow survival packs to be dropped from the aircraft, and therefore this task is best trained at the operational squadron. The remaining tasks have such low TD ratings (Appendix E) that they can be easily assimilated without formal training.

To identify training which may be provided at SAN which is better provided at the operational squadrons (and also at other training schools such as OTS), the Syllabus Objectives were compared to a list of those tasks deleted from the inventory on the basis of aircraft type specificity, that is, tasks which were not performed by PLTOFF/FLGOFF navigators on all aircraft types. Objectives were identified which trained for the following tasks: B287-Operate HF (High Frequency radio) in TTY (Teletyping) mode, B137-Establish aircraft position using

pressure pattern, and B371-Use gyro/grid techniques. Task B287 is specific to P3C aircraft operations and the other two tasks are techniques practiced by C130 navigators only. These latter tasks are performed by 30.2% and 32.6% of PLTOFF/FLGOFF respondents but these percentages represents less than 21% of the total population. Based on this low PMP, both tasks are best trained by OJT at the operational squadrons, and should be deleted from the syllabus.

Task B287 requires further discussion. The ground training syllabus for the navigator course includes the subject "Teletyping" and allocates 60 periods of which two describe the teleprinter, its operation, and the general theory of teletyping. The remaining 58 periods are allocated to "Practice Touch Typing to 20 words per minute using upper and lower case" (39:3-65) and prescribe an attainment level code of 2 (see Appendix D). While typing is a useful skill to possess, particularly in the computer age, only the P3C aircraft possesses a teleprinter which is also used as an input device to the aircraft computer system. Therefore, 60 periods of the course (almost eight days) are spent training a task which is performed by 44.2% of PLTOFF/FLGOFF respondents but only 27% of the population, a sufficiently low PMP to rate the task as OJT, best trained on conversion training.

An argument against training the task at SAN can also be made on the extinction theory principle. Any navigators that do not practice the skill after graduation may require re-training in teletyping if they are subsequently posted to the maritime squadrons. RAAF training managers should therefore investigate transferring teletyping training to P3 conversion courses.

Another Communications related subject warrants discussion, Morse Code. This subject has as its CTO, "to be effective (at the effective level of attainment) in receiving morse cypher at 6 words per minute" and is provided to allow students to recognise morse code and thus decipher radio navigation aid signals which transmit a two or three letter station identification code (39:1A2, 3-53). Recognise is the key word here; the codes are not transmitted rapidly, and most radio navigation charts provide individual station decodes or a listing of morse code to aid in translating the code.

The subject accounts for 17 syllabus periods and requires attainment of level 1 in the Syllabus Objectives, yet only level 2 in the CTO. This disparity aside, good navigation practice demands that all radio navigation aids be identified prior to using any information provided by them, thus avoiding the possibility of tracking or fixing from an incorrect station. Therefore, a syllabus objective which requires level 1 attainment of morse code at 6 words per minute appears to be overtraining for this requirement. Interestingly, decoding morse code transmissions is not listed as a task in the inventory although it could be considered a sub-task of establishing aircraft position by radio navigation aids (task B199). Consideration should be given to reducing the level at which morse code training is provided to one more commensurate with the actual task. The extinction theory also applies in this situation; decoding navigation aid identification signals will not maintain the skill at 6 words per minute.

Course Emphasis

As previously mentioned, seven subjects provide task training that accounts for all 123 essential and desirable tasks in the inventory at Appendix E. These subjects account for 538 periods of the 1202 periods allocated for ground training (including examinations and simulator exercises but excluding additional periods allocated for supplementary tutorials and simulator exercises), or 44.8% of the ground training phase of the course. An examination of the syllabus objectives for the remaining subjects of the course revealed that nine subjects represent a further 271 periods (22.6%) and provide knowledge as opposed to task training. These subjects are Compasses, Computers, Electronic Theory, Instruments, Mathematics, Meteorology, Performance (including general aerodynamics), CR&EW (Communications, Radar and Electronic Warfare Theory), and Weapons. The remaining ground subjects are grouped together in the syllabus as General Service Training and account for 283 periods. These subjects provide training for tasks that all RAAF officers are expected to perform; such tasks were not included on the task inventory as they are not specific to the Navigator Category.

The RAAF Manual of Training, Policy and Procedures directs that training is to be task oriented and states that "The theory content of training is to be kept to the minimum commensurate with safe, effective task performance" (37:1-1). Table 3 provides a categorization of the number of Syllabus Objectives for each of the listed subjects by attainment code. Objectives which prescribe an attainment level of A require a greater level of student mastery than those which rate attainment level C. This distinction gives an indication of the importance placed on particular objectives by the course designer.

Table 3 indicates that a large proportion of total course periods is allocated to theory instruction and much of this training is at the Important or Essential level (refer to Appendix D for the definitions of these terms).

Table 3

Syllabus Objectives By Attainment Code

Subject	Periods	Objectives/Attainment Level					
		A	B	C	1	2	3
Compasses	24	3	18	2			
Computers	47		45	1		1	
Electronic Nav Aid	40		36	2	4		
Electronic Theory	19		35				
Instruments	12	2	16		4		
Mathematics	23	7	26				
Meteorology	33	14	53	25			
Performance	14		30	1			
Physics	25	1	46	2		3	
Communications, Radar and Electronic Warfare	58		91	7			
Weapons	16			19			
<u>General Service Training</u>							
Basic Military Orientation	8	2	12			2	
Current Affairs	10			12			
Drill and Ceremonial	8				7	10	
Physical Fitness	136					6	11
Forward Area Training	24	5	2		1	1	1
Operations Management	21	1	60	52			
Oral Communication	16		2			3	1
RAAF Management	6		7	10			
RAAF Procedures	5	1	13	3		1	
Weapon Training	18	2	2			10	
Written Communication	9		10			5	3
Consolidation Exercise	8	*****************************					
TOTALS	509	38	508	136	16	42	16

NOTE: Consolidation Exercise is a classroom simulation of typical events which arise during a day spent as duty officer. The syllabus does not specify an attainment level, neither does it specify what those events are.

The survey data did not provide an empirical means to assess the optimum theory content of the course, and a subjective analysis provides opinion rather than evidence. RAAF training managers should examine the proportion of theoretical training provided, particularly in subjects such as Compasses, Electronic Theory, and Communications, Radar and Electronic Warfare to ascertain if too much emphasis is placed on theory training at SAN.

Several other points which arise from an examination of the objectives from ground training are worthy of comment. The subject titled "Computers" allocates 22 periods to computer programming in PASCAL with an attainment level of B. Yet none of the tasks identified as essential or desirable from the task inventory requires the use of that skill. The syllabus states that the aim of the programming serial "is to provide students with an introduction to the problems of practical programming and to the use of structural programming to alleviate these problems" (39:3-73). Given the directions from the RAAF Manual of Training Policy and Procedures, that aim appears to conflict with the principle that training objectives are to be derived from job requirements. AFM 50-2 makes a much sharper point, "Training is costly: give it only when there is a need" (10:6). From a theoretical standpoint, any skill obtained from instruction in programming requires practice to avoid extinction; such practice is not evident from the OA data used in this thesis, and this aspect of the course should be reviewed by training managers.

A significant portion of the course is also devoted to General Service Training. Navigator cadets undertake the Junior Officer Initial Course and the Junior Officer Extension Course at Officer Training

School (OTS), RAAF Point Cook, before commencing navigator training. The syllabus for these courses was not examined and therefore overlap between courses was not identified. However, RAAF Navigators are also officers in the Royal Australian Air Force, and the general service training provided at OTS must be re-inforced to reduce the effect of extinction while students are at SAN and thus allow them to function as officers immediately upon graduation. Therefore, a degree of overlap is highly desirable to limit extinction of the knowledge required to perform the tasks of a junior officer, but a decision as to what is optimum is not possible on the data available.

Theoretical Construct of Syllabus Objectives

Investigative questions 4 and 5 both relate to the theoretical construct of syllabus objectives. These questions are:

> What are the specific training standards and how are they reflected in the syllabus? and
>
> What measurement criteria are used to determine effectiveness of the training?

For ease of discussion these questions will be treated together.

As reported in Chapter II, Defence Instruction (Air Force) AAP 2002.001, Manual of Training Policy and Procedures, is the authoritative document which governs RAAF training. Chapter 7 of the manual states that "a training course syllabus is the authoritative document on which all training is conducted" and gives specific direction as to what a syllabus must contain, including the need for well written training objectives (37:7-1). The manual directs that training objectives be written to describe student behaviours which are "unambiguous,

observable and measurable," and, as discussed in Chapter IV, a description of the task to be performed, the conditions under which it is to be performed, and the standard to be achieved" (37:4.1). This requirement is in keeping with the ISD approach.

AFM 50-62, *Handbook For Air Force Instructors* (8) provides a much greater depth of treatment of this subject and draws its discussion from AFM 50-2, AFM 50-58 Volume 3, and numerous authoritative texts. This manual specifies conditions, performance criteria and standards as the minimum components of an objective for a particular learning task and states that an objective in this context "should be a clear statement which communicates the intended outcomes of learning" (8:5-2). This philosophy agrees conceptually with the RAAF manual.

The guidance and direction of these documents were applied to the objectives contained in the Navigator Course Syllabus. The process revealed shortcomings in application of the theory to the writing of objectives by the original course designer. For example, the Course Terminal Objectives for the flying ability of a graduate navigator state under the heading "SKILLS AND KNOWLEDGE":

> Attain the following level of flying skills in respect of the training aircraft:
>
> (1) effectively navigate the aircraft in automatic and manual operating modes;
>
> (2) effectively navigate the aircraft using procedure likely to be encountered in operational squadrons;
>
> (3) be effective in air-ground-air communications ... (39:1- A1)

These objectives have attainment level codes of 2, 3 and 2 respectively. From Appendix D these codes represent:

> 2 <u>Effective.</u> Has reached an effective level of performance; could cope with common problems; could apply skill and

associated knowledge to new situatio s with moderate confidence only; needs normal supervision; and

3 Trained. Has performed the task (actual or simulated), or its essential elements, or has sufficient task knowledge and general experience to be able to perform the task; is aware of common problems; could apply skill and associated knowledge to new situations, with limited confidence; needs maximum supervision. (39:1:B1)

Admittedly, this first objective is taken from the general statement of Course Terminal Objectives and is therefore supposed to be general in nature, but the statement of flying ability with its associated attainment level begs several questions. How does one measure effective performance, particularly when the attainment code defines effective as "has reached an effective level of performance"? The definition and measurement criteria are therefore fundamentally flawed because the definition includes the term being defined. The remainder of the definition for attainment level 2 provides a little more insight but is still extremely general.

In the hope of finding more insight, the Syllabus Objectives for the 22 training flights were then examined. For Flight 1, the first assessable training exercise in the HS748 aircraft, the syllabus states the objectives as:

a. Navigate by tracking from radio aid to radio aid.

b. Calculate ETAs (estimated times of arrival) based on best available groundspeed. (39:2-1)

and prescribes an attainment level of 3. For Flight 5 the objective is "Navigate using manual airplot with best available aids" with an attainment level of 2 (39:2-1) and for Flight 17; "Navigate using best available aids following a hi/lo flight profile to achieve a TOT (time on target)" also with attainment level 2 (39:2-3).

In these examples, which are representative of the objectives for all 22 flights in the HS 748, only the objective for flight 17 seems to provide the "easily measurable" terms as required by the manual of training, the attainment of a Time On Target (although there is no stated range for an acceptable TOT such as ± 15 seconds).

Notwithstanding this fact, the standards required are not clearly defined by the attainment code. A student's ability to navigate in terms of "an effective level of performance" cannot accurately be measured on the objective stated for Flight 5.

In contrast, AFM 50-62 provides guidance to USAF training personnel for specifying standards, including the following:

a. Reference to external authorities, rating scales or regulations;

b. Expressing or implying percentages or ratios (eg 100% accuracy, obtain 8 out of 10, ...);

c. Specifying physical measurements or tolerances;

d. Specifying degrees of supervision or assistance; and

e. Specifying the rate of production. (8:5-12, 5-13)

Applying this direction to the objective for Flight 5 yields an objective such as "Navigate the training aircraft on a route to be specified, using manual airplot techniques with best available aids. The student should maintain the aircraft within 10 nm of flight planned track and achieve ETAs within 2 minutes unless operational considerations dictate otherwise." This objective leaves the reader with no doubt as to the required behaviour and demonstrated standard.

Having identified shortcomings in the Air Training objectives, representative objectives from ground training subjects were then examined with emphasis on Air Navigation, the core ground training

subject of the navigator course. The majority of these objectives appear to be better stated than the examples from the Air Training section. For example, the second serial under the title "The Earth" had as its objectives:

> Define: a. The shape of the Earth; and
>
> b. Meridians, parallels of latitude, great circles, small circles, the equator, the poles and rhumb lines. (39:3-7)

and prescribed an attainment level of B and A respectively. From the definitions at Appendix D, those codes represent levels of performance of "Essential" for A, described as:

> material which is directly necessary for safe and effective practical performance. All A coded material must be examined and in most cases 100 percent accuracy should be required.

and "Important" for B, described as:

> material which is likely to affect practical performance. At least 85 percent of B coded objectives are to be examined. A reasonably high level of student attainment is required. (39:4D-1)

As these objectives stand, they are quite specific; the key word define is unambiguous and the objectives list what is to be defined. Other examples include "Describe the method of construction of a three position line MPP (most probable position) (39:3-22) and "Solve interception problems by graphical means and on the Mk 4A DR computer" (39:3-31). However, when the required standard is added, the ambiguities begin. In what cases will 100% accuracy be required? Is 100% required or should it be required? What is a "reasonably high level" of student attainment? These points should be clear from a clearly stated attainment criteria, not leave the reader, and most importantly the student, guessing. An obvious problem from the instructor's point of view lies in determining the material to be taught

and examined. When attainment codes (and objectives as a whole) are not clearly stated, a lack of consistency between students with different instructors becomes possible.

This finding suggests a problem with the policy and direction in the RAAF Manual of Training, more so than with the syllabus itself, because the manual directs that the codes be copied verbatim from its own Annexes A and B to Chapter 4 (37:4-1). In its partial defence, however, the manual does state that "where more precision is required, the standard may be written into the performance statement" (37:4-2).

Nevertheless, the examination of syllabus objectives with the guidance of the ISD documentation has revealed that RAAF training policy may need to be re-examined from the point of view of depth of application of the theoretical training principles which are evident in the RAAF Manual of Training Policy and Procedures, but which are more obviously applied in the ISD process. More germane to this research, the objectives for each subject in the syllabus should be assessed by RAAF training specialists in the light of this finding to ensure that objectives relay the intent of the course designer, and more importantly serve the following purposes, as stated by AFM 50-2:

1. Serve as a basis for instructional strategy decisions.
2. Determine appropriate content of the instruction.
3. Serve as a basis for instructional media decisions; and
4. Serve as a basis for criterion-referenced tests with a readily measurable standard for attainment. (10:25)

Rewriting of objectives may require an expansion of the wording to reduce ambiguity, and to specify the standard in easily measured terms.

An additional finding was also uncovered in this step of the analysis. The current RAAF Manual of Training Policy and Procedures was issued in February 1988 and is not complete. Four chapters, "Selection of Training Media, Evaluation of Training, Management of Training, and Organisation of Training Establishment" have yet to be incorporated. The syllabus under evaluation was last formally amended in March 1985. Conceivably, syllabuses of instruction for many RAAF training courses may pre-date the latest training policy by even longer periods of time. This suggests that a review of all RAAF training courses may be necessary to ensure that the theory evident in the latest iteration of the RAAF Manual of Training Policy and Procedures is reflected in these courses. The ISD methodology provides a sound basis for this task.

Question 5 - The Evaluation Aspect

Having discussed the theoretical construct factors behind investigative question 5, it is also necessary to discuss the evaluation aspect.

Graduation Requirement. Starting at a general level, and already mentioned in Chapter II, the syllabus does not appear to state a specific graduation requirement, such as that provided in AFIT LS Operating Instruction 50 -1 which states *inter alia*:

> To be eligible for award of the Master of Science Degree, a student must be able to satisfy the following specific requirements:
>
> 1. Demonstrate the ability to achieve the degree program objectives described in Attachment 1 to this OI;
>
> 2. Be in residence for at least three quarters;
>
> 3. Complete all required undergraduate and graduate courses;

4. Complete independent research;

5. Attain a cumulative grade point average of at least 3.00;

6. Achieve grades of at least "C-" or "S" in all required course work ... (40:123).

By comparison Section I of the RAAF Syllabus of Air Training, Navigator (and of all RAAF training syllabuses by direction of Chapter 7 of the RAAF Manual of Training Procedures and Policy) begins with the course title and the aim of the course, which is

> to train members to perform the basic duties of a junior commissioned navigator in the Royal Australian Air Force. The graduate will require operational conversion training before being employed as a navigator in an operational squadron. (39:1)

The section continues with required qualifications for students and then states a graduation status:

> the graduate must be capable of undertaking the duties of an aircrew officer and continuing with further officer education programmes. The graduate will require further training before being employed as a navigator in an operational squadron. (39:2)

and then refers the reader to the Course Terminal Objectives which begin with a restatement of the aim of the Navigator Course. This whole section of the syllabus is titled "Course Graduation Requirement," but nowhere are the actual requirements specified in terms of student performance; the requirement to satisfy the Course Terminal Objectives is implied rather than stated.

The syllabus directs that "course assessments are to be made in accordance with Defence Instruction (AF) AAP 995.1, Section 4, Chap 2" (39:1-11), but that publication no longer exists; it has been replaced by the Manual of Training Policy and Procedures. Chapter 7 of this publication provides guidance for student testing and assessment but

still does not specify the grounds under which a student would fail to graduate.

RAAF policy for suspension of students from training courses is contained in Defence Instruction (AF) Personnel 13-26, *Suspension Action and Disposal From Training Courses: Policy and Procedures* (DI(AF) PERS 13-26) (38). Paragraph 2 of this instruction directs that suspension of students from RAAF training courses is warranted in the following circumstances:

1. Inability to meet course objectives;
2. Personal qualities;
3. Disciplinary reasons;
4. At student's own request; and
5. Any other reason that renders a student's continuance on course inadvisable. (38:1)

These requirements are still quite general but provide the Commanding Officers of the training schools with a great deal of flexibility with regard to suspension decisions. In a telephone interview, the Chief Navigation Instructor at SAN expressed a strong opinion that such flexibility far outweighed any theoretical gain from having suspension criteria based on a set number of failures in air work, or a failure of a defined number of exams in ground training (35). Nevertheless, the students need some indication of the rules to be applied, and whether that indication is in a form such as the AFIT graduation requirement, or a statement of the DI (AF) PERS 13-26 requirements is a matter for further research. While highlighting the shortfall, the current research was unable to uncover an empirical solution.

Individual Subject / Flight Assessments

From the theory in Chapter III, one function of testing is to ensure that students are meeting the training objectives, and another is to ensure that those objectives are being adequately taught. Evaluation as a factor affecting the learning process was also referred to in Chapter III.

For ground training subjects, the syllabus specifies periods for examinations in each subject and provides weighting factors for each subject to be applied to students' results to facilitate calculation of the graduation order of merit (39:1-6). While tests were not available for analysis for this research, the author recalls from experience that this testing was criterion-referenced during his tenure at SAN, and not normative and this fact was confirmed with the Chief Navigation Instructor by telephone interview (35).

For Air Training subjects the syllabus directs that all air exercises are to be analysed and assessed, and a formal debrief provided prior to the next air exercise. Again from the author's experience as an instructor at SAN, this process involved the instructor's checking each entry of the student's log and plotting chart for plotting errors and errors in computation rather than meeting the stated objectives for the sortie. A punitive scale of point deductions was applied to assess the student's work and the resulting grade was weighted depending on the particular exercise and contributed to the graduation order of merit (39:7).

The covering letter to the syllabus amendment, now under trial at SAN, mentions a decreased emphasis on testing from that described in the old flying syllabus (which specified "Phase Checks" at the end of each

phase of air training), and represents a departure from the quantitative analysis of errors on the students log and charts, described above (32:1). As the SAN Commanding Officer states in his letter:

> The amendment allows for a smoother course flow and also is consistent with the philosophy of teaching rather than testing. Each flight will have a teaching component, a consolidation component and a checking component thus allowing information to be taught without the need for separate phases and phase checks as occur now. (32:1)

This is a radical step for SAN which has been criticised for promoting a strict compliance of navigation procedures and focussing the student's attention on procedural entries on a log rather than navigating the aeroplane (33:2). Crooks would characterise this as an evaluation pressure likely to hinder task performance (5). Squadron executives interviewed during the 1989 SAN validation team visits hypothesised that this type of pressure led to shortfalls in the student's ability to prioritise tasks and make decisions, particularly under the added pressure of the tactical environment because he had been trained in an environment which concentrated on evaluation of procedural performance rather than the task itself (33:2).

This finding is perhaps the most significant to emerge from this research, and the SAN response by changing the evaluation method for flying training for the current course means that this aspect must be validated after graduates of the current course commence conversion training in 1991. This factor had a direct bearing on research to answer investigative question 6.

Question 6

How well is the course meeting the needs of the operational squadrons?

This question relates to Step 4 of the methodology and given the changes to the syllabus reported in this thesis, a worthwhile answer can only be obtained after graduates from the present course begin operational flying, sometime in mid 1991. However, the recommendations of the 1988 Occupational Analysis Report and the findings of the 1989 SAN Validation Visit Report, both of which prompted the syllabus amendment, were reviewed and a brief discussion follows.

Occupational Analysis Findings

The survey instrument for the occupational analysis included a section for respondents to make comments on their perception of the training provided at SAN. Unfortunately, the data which resulted were not available for analysis for this thesis. The 1988 report summarised the responses which included:

1. Requests for an increased exposure to Inertial/Omega operation;
2. More emphasis on low-level tactical flying;
3. More emphasis on communicating and navigating at the same time;
4. Less emphasis on plotting;
5. Less training in typing; and
6. Less emphasis on Astro during flying exercises. (28:17)

These comments mirror some of the findings of this thesis, in particular comments 4 through 6, and with the exception of 1 and 5, all have been addressed in the syllabus amendment (32:1). The author of the 1988 report remarked in his findings that "training should keep pace with the introduction of new navigation equipment and the changing role of the navigator" (28:18) and recommended that "Nav equipment on the

HS748 should be upgraded to more accurately reflect the equipment of the operational world" (28:23). As reported in Chapter I, a planned upgrade of navigation equipment in the HS748 to include an Inertial Navigation System (INS) has been approved (30) and that project should be pursued as vigorously as possible to address the identified need.

A major finding of the occupational analysis, that "navigator training appears to be meeting current job requirements" (28:18) was made on data collected from two questions in the survey and the nature of the written responses summarised above. The questions asked respondents to rate the SAN course on content/presentation and length and the report summarised the data collected in terms of "Poor," "Moderate," and "Good" for the former, and "Too Long," "About Right," and "Too Short" for length (28:17). The conclusion was therefore made on extremely general measurement criteria. However, the report also recommended that training staff "validate the course against the tasks actually performed in the field" (28:23). The methodology employed in this thesis matched syllabus objectives against tasks performed in the field, and the results obtained support the conclusion of the occupational analysis.

1989 SAN Validation Tour Report

Some of the findings of this report (33) have already been discussed. The recommendations which resulted from the tour are as follows:

1. An increase in the number of operationally oriented flights including:
   a. low level flight over land using both visual and radar navigation techniques to make good a time-on-target (TOT);

b. low level flight over water, including searches for and homings to selected targets; and planning and flying multi-stop air-route exercises with emphasis on fuel management and adherence to a time schedule.

2. Emphasis in teaching practical mission-orientated navigation techniques and concepts such as:
   a. low level radar ground mapping;
   b. radar terrain avoidance;
   c. radar weather avoidance;
   d. airmanship and crew co-ordination and co-operation;
   e. spatial awareness.

3. Changes to the Communications syllabus to emphasise navigation and tactical communication as a combined requirement rather than separate entities as presently taught.

4. An assessment of subject matter in ground training subjects and in particular Compasses, Electronic Theory, and Computing, to reduce the theoretical content of the course.

5. A continued effort to foster Officer Qualities and maturity in students, and an increased awareness of RAAF customs and etiquettes. (33:2-4)

These recommendations appear to have been the catalyst for the amendment to the syllabus now on trial. The responsiveness of SAN management to squadron requirements displayed in this and the preceding section is a manifestation of a feedback and evaluation loop, equivalent to step 5 of the ISD process, and a major strength in the training philosophy of the RAAF.

Summary

This chapter reported the results obtained from the application of the methodology in Chapter IV to data obtained from a 1988 Occupational Analysis of the RAAF Navigator category and an examination of the Syllabus of Air Training Navigator, and the RAAF manual of Training Policy and Procedures. Answers were provided to the investigative questions posed in Chapter I and relevant findings from the Occupational Analysis and the 1989 SAN validation tour were discussed.

The findings allow answers to the Reserach Questions posed in Chapter I, and these will be discussed in Chapter VI.

VI. Conclusion and Recommendations

The aim of this thesis was to evaluate the syllabus of training currently used for the RAAF Navigator Course in terms of an external measure of curriculum design. The Instructional Systems Design process, used by the USAF for the design and revision of its training courses was selected for this purpose. However, as a consequence of the literature review in Chapter III, the enormity of such a task soon became apparent.

A complete evaluation must involve both an external (field) evaluation, and an internal (on-site) evaluation if a complete analysis is to be made. The internal evaluation of the RAAF Navigator Course was not feasible from abroad. The School Of Air Navigation has recently completed an internal evaluation and the report of that effort is currently being studied by Training Command staff (31). This thesis should therefore be read in conjunction with that report once it is made available for general dissemination.

As it stands, this thesis was able to obtain answers to the eight investigative questions posed in Chapter I, and those findings, discussed in Chapter V, will now be used to answer the research questions.

Question 1

Does the syllabus of training for the RAAF Navigator Course, adequately reflect the training required by an SAN graduate in order to transition to operational flying duties?

Notwithstanding the concerns expressed in Chapters I and II which in part prompted this research, and the fact that there are as yet no

graduates of the course as it is currently operating (as a result of the SAN amendment proposal of 23 October 1989), the findings would seem to indicate that the syllabus does reflect the required training. Although the original data was collected in 1987, there have been no major changes to the roles or configurations of RAAF aircraft that carry navigators which would render that data obsolete.

Of the 481 tasks on the original task inventory, 123 were identified as either essential or desirable for training at SAN. Training objectives for all of these tasks were identified in the syllabus. In addition, the amendments which were made to the syllabus, and in particular the changes to the evaluation and content of the Air Training components of the old syllabus, were all instigated by SAN in response to squadron feedback on their requirements for SAN graduates.

Question 2

Does the current RAAF Navigator Course contain material that is not relevant to present operational squadron requirements, or material that is more applicable to squadron conversion training?

Areas of redundancy and possible over-training of theory were identified, and training managers should critically examine the stated objectives and the required level of attainment for the following subjects to reduce theory content to "the minimum commensurate with safe, effective task performance" as directed by the RAAF Manual of Training Policy and Procedures. The subjects are: Compasses, Computers, Electronic Theory, Instruments, Mathematics, Meteorology, Performance (including general aerodynamics), CR&EW (Communications, Radar and Electronic Warfare Theory), and Weapons.

Consideration should also be given to transferring responsibility for training in teletyping to 92 Wing given that P3 navigators are the only sub-group identified by the occupational analysis that perform this task operationally. Similarly training for use of gyro/grid procedures and pressure pattern fixing should be transferred to the C130 squadrons as navigators on P3 and F-111C do not require these skills.

Question 3

Are there significant differences in training methods and ideologies between the USAF and the RAAF, and if so, can the RAAF benefit by adopting USAF training methodology?

The literature review revealed that the RAAF and USAF share similar philosophies in relation to training, both based on contemporary educational theory. The analysis uncovered an apparent difference in the degree of application of the theory, particularly in the wording of syllabus objectives and the general nature of much of the syllabus content. These are theoretical considerations rather than practical, but are worthy of closer examination by RAAF training specialists. The rationale that RAAF training objectives are specified in general rather than specific terms due to a requirement for a more broadly trained workforce was not tested in this thesis, but appears to account for some differences at the operator level of training. That issue may be worthy of further research.

Overall Findings and Recommendations

Overall, the RAAF Navigator Course appears to be meeting its aim of providing training to allow graduates to perform the basic duties of a junior commissioned navigator in the Royal Australian Air Force. The

amendment to the syllabus which is presently on trial, and which is expected to be incorporated officially with Number 79 Navigator Course, addressed many of the perceived shortcomings which prompted this research. However there are still some areas which can be improved and the following recommendations are presented:

1. Typing training should be transferred to 92 Wing, and training in gyro/grid and pressure pattern should be provided at 86 Wing, not SAN.

2. RAAF training specialists should examine the ground training syllabus and particularly subjects such as Compasses, Electronic Theory, Computers, Communications, Radar and Electronic Warfare, Morse Code and the General Training Syllabus to identify areas where over-training of theory is occurring. Theory in excess of the "minimum commensurate with safe, effective task performance" (39:1-1) should be eliminated.

3. RAAF training specialists should examine the wording of syllabus objectives to ensure that they relay the intent of the course designer, and more importantly serve the following purposes:

   a. Serve as a basis for instructional strategy decisions.

   b. Determine appropriate content of the instruction.

   c. Serve as a basis for instructional media decisions; and

   d. Serve as a basis for criterion-referenced tests with a readily measurable standard for attainment. (10:25)

5. RAAF training specialists should examine the wording of the attainment codes in the RAAF Manual of Training Policy and Procedures to remove ambiguity and flawed definitions.

6. RAAF training specialists should review of RAAF training courses to ensure that the theory evident in the latest iteration of the RAAF Manual of Training Policy and Procedures is reflected in the syllabuses of these courses.

Appendix A: Complete Task Inventory From 1986-87 Occupational Survey

This task inventory was extracted from the survey instrument used to collect data for the Occupational Analysis of the RAAF Navigator Category (27), the results of which were used as data for this thesis.

After first completing a Background Information Section (which provided demographic and worker trait data), respondents were asked to mark those tasks from the task inventory which they performed in their employment as navigators. They were then asked to annotate each task so marked for Relative Time Spent on a nine point scale. Finally, respondents were asked to code each task for Training Emphasis (TE) and Task Learning Difficulty (TD) as described in Chapter IV of this thesis.

DUTY A PRE-FLIGHT

1. Arrange activation of air weapons ranges
2. Arrange for accommodation, ground transport, etc
3. Arrange for diplomatic/overflight clearances
4. Arrange for flight authorization
5. Arrange NOTAMS for low level aircraft routes
6. Attend crew operational briefing
7. Attend met and air traffic control briefing
8. Attend oceanographic briefing (water conditions, range of day)
9. Attend strike briefing
10. Authorize flights
11. Brief crew/s on sortie
12. Brief passengers on safety
13. Calculate all up weight
14. Calculate and set camera settings
15. Calculate doors open/close times
16. Calculate equi-time points and/or point of safe return
17. Calculate fuel requirements for mission
18. Calculate point of safe diversion
19. Calculate prudent limit of endurance (PLE)
20. Calculate radius of action
21. Calculate takeoff performance (eg V1, V2)
22. Challenge/reply to aircraft checklists
23. Check existence and currency of a/c documentation
24. Check flight authorization documents
25. Check NOTAMS applicable to Sortie
26. Collect materials/intelligence concerning target/DZ

27. Complete pre-flight administration (form browns, greens, etc)
28. Coordinate employment of ASW sensors
29. Coordinate low level routes/ sorties for collision avoidance
30. Decode order/exercise instructions
31. Determine configuration of ordnance/stores
32. Determine landing weight
33. Determine max payload for operation
34. Determine rescue equipment requirements
35. Determine route and mission profile
36. Determine safety heights
37. Determine SAR patterns (contour, square, etc)
38. Determine suitability of airfield for operation
39. Fit flying clothing and safety equipment before flight
40. Initialize computer system
41. Load cryptographic material
42. Load pre-flight data into computer system
43. Load rations and personal equipment/clothing
44. Obtain ATC clearances
45. Obtain time check
46. Order and collect imprest/ES4
47. Order cryptographic material
48. Order film upload
49. Order fuel
50. Order met forecasts/ASRAPS etc
51. Order mission tapes
52. Order ordnance/stores
53. Order radar predictions
54. Order rations
55. Page check cryptographic materials
56. Perform pre-flight on a/c externals
57. Perform pre-flight on acoustics detection equipment
58. Perform pre-flight on cameras
59. Perform pre-flight on electronic aids and comms equipment
60. Perform pre-flight on EW equipment
61. Perform pre-flight on IFF
62. Perform pre-flight on infrared detection equipment
63. Perform pre-flight on MAD
64. Perform pre-flight on navigation equipment
65. Perform pre-flight on ordnance
66. Perform pre-flight on radar equipment
67. Perform pre-flight on safety equipment
68. Perform pre-flight on SAR equipment
69. Perform pre-flight on stores and equipment
70. Perform pre-flight on trails instrumentation
71. Perform target/target area DZ study
72. Plan mission Nav/Comm
73. Plan ordnance mission buoy load
74. Plan photographic recce
75. Plan photographic survey
76. Plan sonar buoy management
77. Plan weapons/stores delivery
78. Prepare acoustics data for mission
79. Prepare and conduct EW briefing

80. Prepare and conduct oceanographic briefing
81. Prepare documentation relating to customs, health, immigration
82. Prepare EW data for mission
83. Prepare maps/charts and associated documents for sortie
84. Prepare miscellaneous equipment (tapes,cameras,binoculars)
85. Prepare mission tapes
86. Prepare navigation flight plan
87. Prepare operations orders/admin instructions
88. Prepare radar prediction
89. Prepare tactical operations plan
90. Program offsets
91. Receive VIPs formally onto a/c
92. Select fisheries patrol search
93. Select offsets/turn points/descent points
94. Select target from reconnaissance information
95. Stow RAAF or GG standard
96. Submit a before flight message
97. Submit navigation flight plan to ATC for approval
98. Supervise outfitting of passengers
99. Upload film

DUTY B IN-FLIGHT

100. Adjust SAD threshold
101. Advise TACCO of tactics required to maintain contact/tracking
102. Alter flight plan in-flight
103. Alter tactical sortie in-flight
104. Analyse aerological diagram to predict true altitude
105. Analyse sonar contact (type, signal strength, depth, etc)
106. Assess and determine localization procedure/pattern
107. Assess and determine signature criteria for targets
108. Assess tactical importance of acoustical contact
109. Assess target information from data link
110. Assess total tactical situation
111. Assess validity of data from acoustics equipment
112. Assess validity of data from EW equipment
113. Assess validity of data from NAV equipment
114. Assign target information to data link
115. Brief instrument approach
116. Calculate acoustic target depth
117. Calculate acoustic target speed, range and heading
118. Calculate air release point (CARP) for load/banner
119. Calculate air speeds (TAS IAS MACH)
120. Calculate altitudes (true, pressure, absolute, density)
121. Calculate critical points
122. Calculate drift down altitude
123. Calculate ETA's
124. Calculate ground speeds
125. Calculate high altitude release point (HARP)
126. Calculate in-flight winds
127. Calculate intercept heading/time for aircraft/ship
128. Calculate/monitor aircraft in-flight performance
129. Calculate most probable position

130. Calculate predicted sonar ranges
131. Calculate ramp time
132. Calculate SOA/SOA required
133. Calculate thermal crossover
134. Calculate times of celestial risings/settings/twilights
135. Calculate weapon release point
136. Call take off/landing check parameters
137. Classify acoustic contact
138. Classify ESM contacts
139. Classify MAD/SAD contacts
140. Classify radar contacts
141. Classify subsurface contacts
142. Classify surface contacts
143. Collect pollution samples
144. Compile target information reports
145. Compute a/c landing airspeed
146. Compute performance data
147. Conduct assessment of ground based communications
148. Conduct caution and warning lamp analysis using checklist
149. Conduct en-route comms with civil ATC
150. Conduct en-route military comms
151. Conduct equipment fault finding/isolation
152. Conduct SAR patterns
153. Coordinate survival pack drops (eg lindholme/ASRK)
154. Coordinate tactical low level formation manoeuvers
155. Decode/encode messages
156. Decode IFF responses
157. Detect software related equipment faults
158. Determine and plot position course and speed of contact
159. Determine and select anti-clutter circuits
160. Determine and select gamma full scale settings
161. Determine and select MAD band pass settings
162. Determine aspect angle to target
163. Determine aural target characteristics
164. Determine bank angle to obtain optimum flight
165. Determine best hydrophone/transducer depth
166. Determine buoy patterns
167. Determine buoy weightings
168. Determine compatibility of sensor options with other sensors
169. Determine drop sequence of personnel/equipment
170. Determine electronic order of battle
171. Determine IAS and fuel flow for given altitude and weight
172. Determine integrity of cryptographic equipment and material
173. Determine methods of acoustic localization
174. Determine oceanographic conditions
175. Determine optimum routing/altitude for medevac
176. Determine priorities for recording data
177. Determine resolution and integration times for contacts
178. Determine sound path travel of detected signature
179. Determine sound propagation pattern of target
180. Determine source of signature as to target equipment
181. Determine tactical priorities of contact/tracks
182. Differentiate signatures in multiple target situations

183. Direct a/c maneuvers for MAD localization
184. Direct a/c position to MAD predict points
185. Direct a/c tactical evasion of a/c or missile threats
186. Direct a/c to weapon release point
187. Direct a/c terrain avoidance
188. Direct/employ evasive manoeuvers
189. Direct other units during coordinated operations
190. Direct threat avoidance
191. Direct weather avoidance
192. Establish a/c position using celestial
193. Establish a/c position using DR
194. Establish a/c position using infrared imagery
195. Establish a/c position using map reading
196. Establish a/c position using navigational systems (INS/OMEGA)
197. Establish a/c position using pressure pattern
198. Establish a/c position using radar
199. Establish a/c position using radar aids
200. Establish a/c position using visual
201. Gather ecological data
202. Gather met data
203. Hand-over contacts for tactical integration
204. Identify airborne targets
205. Identify and classify infrared contacts
206. Identify and fix acoustic contacts
207. Identify and fix ESM contact
208. Identify and fix position of radar/visual targets
209. Identify MAD contact
210. Identify radar contacts
211. Identify radar fits on visual targets
212. Identify ships
213. Identify subsurface targets and mode of operation
214. Identify weapon systems on visual targets
215. Implement ECCM
216. Initiate weapons/stores release checklist
217. Install Verey pistol
218. Interpret MAD display
219. Interpret topographical maps
220. Jettison/eject stores
221. Load and fire Verey pistol
222. Launch smoke markers
223. Launch stores/weapons automatically
224. Launch stores/weapons manually
225. Load a/c acoustic computer
226. Load a/c central computer
227. Load sonobuoy launch tubes
228. Log contacts
229. Maintain visual cross over in tactical formation
230. Maintain visual surveillance during SAR operations
231. Manage comms usage in-flight
232. Manage crew rotation
233. Manage in-flight usage of ASW stores and weapons
234. Manage input from sensors
235. Measure ambient noise

236. Monitor a/c envelope for proper equipment operation
237. Monitor a/c flight control configuration
238. Monitor air refueling (hook-up) procedures
239. Monitor caution and warning lamps
240. Monitor communications
241. Monitor compliance with ATC
242. Monitor conflicting traffic in uncontrolled airspace
243. Monitor departure and approach procedures
244. Monitor descent profiles
245. Monitor engine instruments
246. Monitor explosive echo ranging
247. Monitor flight instruments
248. Monitor flight profile for radar evasion
249. Monitor formation join-up
250. Monitor fuel systems
251. Monitor instrument approach
252. Monitor minimum altitude
253. Monitor missile engagement zones
254. Monitor OAT indicator
255. Monitor radar anti-icing
256. Monitor radar wave guide pressurization
257. Monitor tactical airspace
258. Monitor TFR radar
259. Measure tracks and distance
260. Monitor traffic in circuit/range
261. Monitor traffic in controlled airspace
262. Monitor visual airspace
263. Monitor weapons/load performance
264. Monitor weapons release envelopes
265. Obtain update of terminal/target conditions
266. Operate a/c camera
267. Operate a/c electrical system
268. Operate ADP
269. Operate AQS-901
270. Operate as track coordinator in data link network
271. Operate attack radar system
272. Operate AVTR panel
273. Operate central tactical system (CTS) link\management
274. Operate CGA
275. Operate countermeasures dispensing equipment
276. Operate covered RATT
277. Operate DMEA
278. Operate doppler
279. Operate drift meter
280. Operate ECM
281. Operate electronic countermeasures systems
282. Operate emergency keyer
283. Operate GBU-15 panel
284. Operate gyro stabilized monocular
285. Operate hand-held camera
286. Operate harpoon control panel
287. Operate HF in secure TTY \mode
288. Operate HF in secure voice

289. Operate HF in voice mode
290. Operate HF/UHF data link
291. Operate IFF interrogator
292. Operate IFF/SIF
293. Operate ILS
294. Operate infrared recorder
295. Operate INS
296. Operate intercom system
297. Operate integrated tactical displays
298. Operate IR system
299. Operate MAD
300. Operate mapping radar system
301. Operate navigation flight computer
302. Operate pavetack infrared detection set
303. Operate pavetack laser designation set
304. Operate periscope sextant
305. Operate radar camera
306. Operate RHAWS system
307. Operate stores release equipment
308. Operate TACAN
309. Operate tape recorder
310. Operate trials instrumentation
311. Operate TV view finder
312. Operate UHF in normal voice
313. Operate UHF in secure TTY mode
314. Operate UHF in secure voice
315. Operate VHF
316. Operate weapons computer
317. Operate weapons/armament panel
318. Operate weather/radar system
319. Perform active acoustic localization
320. Perform airborne alignment of equipment
321. Perform airborne radar approach
322. Perform air/track plot
323. Perform aural monitoring of sensors
324. Perform basic unusual attitude recoveries
325. Perform communications jamming
326. Perform compass calibration auto
327. Perform compass calibration manual
328. Perform emergency 'bold face' procedures
329. Perform ESM homing
330. Perform home-on-jam
331. Perform infrared homing
332. Perform jamming to counter fire control radars
333. Perform load/banner release
334. Perform MAD compensation procedure with/without CGA
335. Perform MAD noise check
336. Perform MAD operational figure of merit
337. Perform off-line ordnance launch
338. Perform passive acoustic search
339. Perform plot stabilization
340. Perform radar homing
341. Perform SAR visual search

342. Perform security checks of aircraft classified material
343. Perform ship rigging procedure
344. Practice a/c emergency drills
345. Prepare data for handover - takeover data link transmission
346. Prepare emergency messages
347. Prepare free-fall chute and liner
348. Prepare in-flight meals
349. Prepare routine messages
350. Prepare sonobuoy for launch
351. Prioritise tracks in tactical situation
352. Program RECCE camera
353. Rectify minor faults
354. Replace/exchange major components (eg. HF transmitter coupler)
355. Restore software to normal operation
356. Select and set ESM band limits
357. Select ASW search tactics
358. Set/program weapon panel for stores release
359. Set-up data link crypto codes
360. Set-up data link hardware/software for transmission
361. Set-up IFF cryptographic codes
362. Track aircraft during photography missions
363. Transfer to infrared sensor from ESM homing
364. Transfer to infrared sensor from radar homing
365. Update equi-time points and/or points of safe return
366. Update point of safe diversion
367. Update prudent limit of endurance
368. Update radar contacts
369. Update radius of action
370. Use authentication procedures
371. Use gyro/grid techniques

DUTY C POST-FLIGHT

372. Use low grade crypto codes
373 Analyse navigation trials results
374. Analyse radar and strike camera film
375. Analyse reconnaissance results
376. Analyse survey results
377. Analyse weapons trials results
378. Complete categorization documentation
379. Complete flight authorization sheets
380. Debrief crew
381. Debrief intelligence staff or photo-interpreters
382. Debrief project officers
383. Dispatch film
384. Down-load survey film
385. File logs and charts
386. Marshall aircraft
387. Participate in aircrew post-flight debrief
388. Perform a/c turn around (eg: refuel, maintenance)
389. Perform external post-flight inspection of the a/c
390. Perform post-flight acoustic analysis

391. Perform post-flight EW analysis
392. Perform weapon system accuracy analysis
393. Post-flight check a/c equipment
394. Prepare mission reports
395. Receive briefing on corrected reported unservicabilities
396. Receive VIPs off a/c formally
397. Reconcile ES4 and flight advance
398. Report serviceability state of a/c equipment
399. Return cryptographic materials to custodian
400. Return miscellaneous equipment (tapes, cameras, binoculars)
401. Submit completed sortie records and miscellaneous reports
402. Unload equipment from a/c
403. Write post-flight report

DUTY D TRAINING

404. Assign instructors
405. Conduct categorization/conversion examinations
406. Conduct continuation training in-flight
407. Conduct continuation training in simulator
408. Conduct continuation training-not simulator, not in-flight
409. Conduct mass students briefings
410. Conduct on-the-Job training
411. Conduct practical skills instruction
412. Conduct theory instruction
413. Conduct yearly assessment flights of aircrew performance
414. Debrief students on airmanship aspects of training flights
415. Evaluate effectiveness of training programs
416. Evaluate training aids
417. Guide and assess instructional staff
418. Maintain audio-visual equipment
419. Maintain categorization documents
420. Maintain training course records
421. Monitor students plotting and navigation procedures
422. Monitor training progress of individuals
423. Monitor training status of section
424. Operate audio-visual equipment
425. Organise training programs or timetables.
426. Plan continuation training
427. Prepare lesson plans
428. Prepare simulator scenarios
429. Prepare student notes/student worksheets
430. Prepare training publications and training aids
431. Prepare training syllabuses
432. Raise course documentation (suspension reports,nominal roll)
433. Research applicable reports relevant to new trails/tactics
434. Review evaluation and work sheets with students
435. Supervise student navigation practice with simulator

DUTY E MISCELLANEOUS

436. Act as airborne scene of action commander

437. Arrange ordnance loading areas to be promulgated
438. Assess crew performance in-flight
439. Assess pavetack radar/IR
440. Assess radar film
441. Assign crew duties
442. Assist in a/c load/reconfiguration
443. Assist in major fault rectifications
444. Conduct before and after-flight servicing
445. Coordinate base search and rescue facilities
446. Coordinate planned flying with maintenance scheduling
447. Debrief met personnel on quality of forecast
448. Define system performance requirement to contractor
449. Determine tactical policy
450. Develop new land strike tactics and procedures
451. Develop new maritime strike tactics and procedures
452. Develop new weapons strike tactics and procedures
453. Diagnose - AVMED/physiological problems in flight
454. Direct ground procedures during engine start, pre-taxi or shutdown
455. Evaluate land strike tactics and procedures
456. Evaluate maritime strike tactics and procedures
457. Evaluate weapons tactics and procedures
458. Load/unload external sonobuoys
459. Manage and direct contractors
460. Manage software configuration
461. Man base Operations Room during exercises
462. Maintain custody of cryptographic materials
463. Maintain operational or technical publications
464. Maintain squadron navigator status
465. Participate in joint tactics
466. Perform comms tasks from Air-Ground-Air Centre/Operations Room
467. Perform emergency egress drill
468. Perform operational assessment of proposed equipment/software system changes
469. Perform periodic review of flight manuals and associated flight publicationss
470. Practice aircrew survival techniques
471. Prepare daily and weekly flying programs
472. Program squadron navigators
473. Report to AIS anomalies in FLIP type documents
474. Research and apply foreign procedures
475. Review contractors design
476. Submit software change requests
477. Submit software trouble reports
478. Supervise crew members
479. Test software updates
480. Validate software trouble reports
481. Write technical reports (28:1-42)

Appendix B: Summary of Course Content by Period Allocation (39:1-2)

Air Training

	Flying Hours		Period Allocation
Scheduled Flying CT4A	7.0		38
Scheduled Flying	153.5		296
Abortive Flying	15.0		33

		SUB-TOTAL	367
			====

Ground Training

		Period Allocation
Air Communications:		
Procedures		83
Security		10
Teletyping		60
Morse		17
HS 748 Conversion		5
Airmanship		36
Air Navigation:		
Theory		139
Simulator Exercises		169
Plotting Exercises		4
Air Traffic Control		32
Astro (Celestial Navigation)		29
Aviation Medicine		38
Compasses		24
Computers		47
Electronic Navigation Aids		40
Electronic Theory		19
Instruments		12
Mathematics		23
Meteorology		33
Performance		14
Physics		25
Communications, Radar and Electronic Warfare		58
Weapons		16
5% Tutorial/Supplementary Examinations/Simulator Allowance		47

	SUB-TOTAL	980
		====

General Service Training

Basic Military Orientation	8
Current Affairs	10
Drill and Ceremonial	8
Physical Fitness	136
Forward Area Training	24
Operations Management	21

General Service Training (cont)

		Period Allocation
Oral Communication		16
RAAF Management		6
RAAF Procedures		5
Weapon Training		18
Written Communication		9
Consolidation Exercise		8

	SUB-TOTAL	269
		====

NOTE: The course also includes 268 non-instructional periods for course administration, Visits, Parades and Public Holidays for a total of 1884 instructional periods (39:1-2).

Appendix C: Navigator Course Attainment Codes (39:1B)

ATTAINMENTS IN PRACTICAL SKILLS

CODE	ATTAINMENT AND DESCRIPTION
1	Expert. has reached a high standard of performance; could cope with difficult and unusual problems; could apply skill and associated knowledge to new situations; needs minimum supervision.
2	Effective. Has reached an effective level of performance; could cope with common problems; could apply skill and associated knowledge to new situations with moderate confidence only; needs normal supervision; and
3	Trained. Has performed the task (actual or simulated), or its essential elements, or has sufficient task knowledge and general experience to be able to perform the task; is aware of common problems; could apply skill and associated knowledge to new situations, with limited confidence; needs maximum supervision.

ATTAINMENTS IN COGNITIVE SKILLS

CODE	ATTAINMENT AND DESCRIPTION
A	Essential. Material which is directly necessary for safe and effective practical performance. All A coded material must be examined and in most cases 100 percent accuracy should be required.
B	Important. Material which is likely to affect practical performance. At least 85 percent of B coded objectives are to be examined. A reasonably high level of student attainment is required.
C	Background. Material which is not likely to affect practical performance, but which may be of general use. Testing is to be at unit discretion and is not to contribute to PASS/FAIL criteria (S:1B-1).

NOTE: The Syllabus of Air Training Course Navigator also provides attainment codes for psycho-motor skills but there are no objectives in this category in the syllabus.

Appendix D: RAAF STANDARD LIST OF COGNITIVE PERFORMANCE WORDS

This listing is drawn from, but is not a complete reproduction of prescribed performance words contained in Annex B to Chapter 4 of the RAAF Manual of Training Policy and Procedures (37:4B-1,2). The performance words are classified in terms of a hierarchy of objectives, from the recall or recognition of knowledge to the development of higher levels of intellectual abilities and skills (37:4B-1).

CLASS	PERFORMANCE	DEFINITION
KNOWLEDGE	State	Express in speech or writing, information previously received. Exact replication not necessarily required.
	List	Catalogue a number of items or points.
	Define	State the exact meaning or peculiar characteristics that identify particular word usage, an object, concept or process.
	Describe	State the features or characteristics of an object, concept or process.
COMPREHENSION	Explain	Account for cause and effect relationships, or account for a situation or requirement.
	Differentiate	Identify distinguishing characteristics between alternatives.
	Outline	Determine and then summarise salient features or points of a situation or occurrence.
APPLICATION	Solve	Find a solution to a problem by application of a rule or procedure to a new situation.
	Contrast	Establish similarities and differences between alternatives.

CLASS	PERFORMANCE	DEFINITION
APPLICATION (cont)	Select	Choose between alternatives by applying rules, guidelines or other criteria.
ANALYSIS	Analyse	Determine basic components and describe relationships.
SYNTHESIS	Plan	Develop actions to achieve a stated goal.
	Design	Use recognised criteria or systematic processes to develop a concept, system, or product.
EVALUATION	Discuss	Examine a concept or plan and apply pre-determined criteria, rules, or guidelines to arrive at a conclusion or required course of action.
	Assess	Examine an item, concept or situation and determine its worth, value, strengths and/or weaknesses.

Appendix E: Navigator Course Training Requirements By Task

Data from the original analysis (28) was classified in accordance with the criteria contained in Table 1 to obtain Training Requirement.

Task No	PMP (All Navs)	PMP (PLTOFF/ FLGOFF)	TE	TD	Training Requirement
B195	66.30	90.70	6.25	5.48	Essential
B252	69.40	88.40	6.73	4.61	Essential
B243	65.30	88.40	6.30	5.03	Essential
B242	75.50	88.40	5.60	5.04	Essential
A39	89.80	88.40	4.81	3.10	Essential*
B198	75.50	86.00	6.69	5.26	Essential
B241	73.50	86.00	5.71	4.68	Essential
A67	87.80	86.00	6.21	4.03	Essential
B123	64.30	86.00	5.72	4.15	Essential
A7	72.40	86.00	5.01	2.90	Essential*
B251	62.20	86.00	6.08	5.11	Essential
B259	75.50	86.00	5.19	3.80	Essential*
B196	62.20	86.00	6.58	4.54	Essential
B128	59.20	83.70	6.03	5.15	Essential
A64	63.30	83.70	6.38	5.19	Essential
B240	80.60	83.70	5.78	4.99	Essential
B200	60.20	83.70	6.36	4.97	Essential
A86	60.20	83.70	6.17	4.94	Essential
A97	61.20	83.70	5.24	3.72	Essential
A83	73.50	81.40	6.67	4.92	Essential
A36	62.20	81.40	7.06	4.46	Essential
B344	86.70	81.40	6.38	4.74	Essential
B219	72.40	81.40	6.63	5.05	Essential
A25	66.30	81.40	6.00	3.97	Essential
A40	82.70	79.10	5.54	4.76	Essential
B244	58.20	79.10	5.24	4.48	Essential
B113	66.30	76.70	7.18	5.84	Essential
B365	54.10	76.70	5.32	5.29	Essential
A17	63.30	76.70	6.92	5.32	Essential
B119	51.00	76.70	5.07	4.28	Essential
B126	50.00	76.70	5.60	4.51	Essential
A42	75.50	76.70	5.59	4.54	Essential
A16	57.10	76.70	6.05	5.30	Essential
B124	56.10	76.70	5.51	4.11	Essential
B192	51.00	76.70	5.91	6.12	Essential
B261	53.10	74.40	4.81	4.48	Essential*
B304	59.20	74.40	5.77	5.50	Essential
B150	64.30	74.40	6.04	5.03	Essential
B341	77.60	74.40	5.47	4.57	Essential
B366	53.10	72.10	5.36	5.27	Essential
A18	54.10	72.10	6.54	5.40	Essential
A59	59.20	69.80	5.78	5.11	Essential

Task No	PMP (All Navs)	PMP (PLTOFF/ FLGOFF)	TE	TD	Training Requirement
B346	48.00	67.40	5.55	4.42	Essential*
B171	45.90	67.40	5.16	4.58	Essential*
B187	63.30	67.40	6.78	5.48	Essential
B239	70.40	67.40	4.78	4.02	Essential*
B289	64.30	67.40	5.38	4.36	Essential*
B193	49.00	67.40	6.13	5.62	Essential
B129	44.90	65.10	5.94	5.50	Essential
A35	64.30	65.10	5.84	5.31	Essential
B295	53.10	65.10	6.64	4.95	Essential
B301	48.00	65.10	6.56	4.99	Essential
B322	41.80	65.10	5.92	5.74	Essential
A72	46.90	62.80	6.32	5.62	Essential
B221	59.20	62.80	4.11	3.56	Essential*
B278	38.80	62.80	4.38	3.62	Essential
B191	61.20	62.80	6.06	5.45	Essential
B151	70.40	62.80	5.79	5.85	Essential
A93	52.00	60.50	5.74	4.55	Essential
B199	46.90	60.50	6.29	4.70	Essential
A66	57.10	55.80	6.03	5.06	Essential
E467	63.30	53.50	5.82	4.38	Essential*
E470	62.20	53.50	5.61	4.62	Essential*
B367	39.80	53.50	5.48	5.15	Essential*
B265	48.00	53.50	5.26	4.15	Essential
A11	72.40	53.50	5.86	5.25	Essential
A19	38.80	51.20	6.43	5.39	Essential*
B231	49.00	51.20	5.44	5.13	Essential
B155	46.90	48.80	5.52	5.07	Essential*
B262	40.80	48.80	4.63	4.31	Essential*
B250	33.70	46.50	4.79	4.61	Essential*
B115	35.70	46.50	5.35	4.75	Essential
B172	32.70	46.50	5.32	5.42	Essential
B132	36.70	44.20	5.67	4.56	Essential
A12	51.00	44.20	4.87	3.78	Essential*
A38	38.80	44.20	4.91	4.51	Essential*
B208	51.00	41.90	5.91	5.52	Essential
B340	45.90	41.90	5.79	5.31	Essential
B318	49.00	41.90	6.49	5.53	Essential
B328	40.80	41.90	6.24	4.81	Essential
B247	31.60	39.50	5.36	4.80	Essential
B152	48.00	39.50	5.47	5.45	Essential
B120	29.60	39.50	4.58	4.47	Essential*
B146	33.70	37.20	5.95	5.00	Essential*
A56	53.10	34.90	5.31	4.37	Essential*
B210	40.80	32.60	5.92	5.65	Essential
B148	39.80	32.60	4.83	4.45	Essential*
B122	25.50	30.20	4.82	4.55	Essential*
A13	20.40	16.30	4.37	4.15	Essential*
A22	95.90	97.70	5.13	3.24	Desirable
B296	98.00	95.30	4.94	3.72	Desirable
A6	95.90	93.00	5.23	2.57	Desirable

Task No	PMP (All Navs)	PMP (PLTOFF/ FLGOFF)	TE	TD	Training Requirement
C398	83.70	90.70	4.48	3.92	Desirable
C387	89.80	86.00	5.16	3.99	Desirable
B102	62.20	83.70	4.97	4.61	Desirable
A50	76.50	83.70	4.51	3.27	Desirable
B312	72.40	76.70	4.96	3.93	Desirable
B134	54.10	74.40	5.00	4.98	Desirable
A23	74.50	72.10	4.44	3.69	Desirable
B149	50.00	62.80	4.93	4.49	Desirable
B260	49.00	60.50	4.72	4.47	Desirable
B342	65.30	60.50	5.24	4.34	Desirable
B257	62.20	60.50	4.91	4.66	Desirable
B370	58.20	55.80	5.65	4.71	Desirable
B372	56.10	55.80	5.56	4.94	Desirable
B253	74.50	55.80	6.25	4.92	Desirable
B230	66.30	55.80	4.59	4.19	Desirable
A30	65.30	53.50	5.69	5.55	Desirable
C393	54.10	51.20	4.69	4.41	Desirable
B349	48.00	51.20	4.23	4.11	Desirable
A61	51.00	51.20	5.50	4.56	Desirable
B157	60.20	48.80	5.39	5.77	Desirable
A44	39.80	46.50	5.00	3.62	Desirable
A47	32.70	44.20	4.40	3.51	Desirable
B315	42.90	41.90	4.19	3.71	Desirable
C380	63.30	39.50	5.13	5.26	Desirable
E474	36.70	37.20	4.10	5.31	Desirable
A20	29.60	32.60	5.68	5.21	Desirable
A27	43.90	27.90	5.07	5.25	Desirable
A45	61.20	79.10	3.73	2.46	OJT
C397	61.20	65.10	3.66	4.56	OJT
C385	58.20	72.10	3.33	3.36	OJT
C401	70.40	67.40	3.84	3.65	OJT
B353	66.30	62.80	4.81	5.20	OJT
C400	65.30	55.80	3.20	3.16	OJT
B217	55.10	53.50	3.74	3.08	OJT
C399	38.80	51.20	4.80	3.43	OJT
A3	55.10	[illegible].20	3.49	3.81	OJT
B202	39.80	48.80	3.90	4.09	OJT
A55	36.70	46.50	4.90	3.13	OJT
B254	30.60	44.20	3.80	3.47	OJT
A24	41.80	39.50	4.27	3.19	OJT
B308	28.60	34.90	3.71	3.53	OJT
E473	32.70	32.60	3.40	3.75	OJT
B147	27.60	32.60	3.90	4.56	OJT
E469	30.60	30.20	3.97	4.69	OJT
B153	46.90	30.20	5.56	5.40	OJT**

NOTES:

1. All remaining tasks from the inventory are classified OJT by virtue of low PMP and TD in the PLTOFF/FLGOFF category, or

are specific aircraft and/or performed by FLTLT tasks.

2. Those tasks classified as Essential* are essential criteria by virtue of safety considerations, and/or are necessary pre-requesites for other essential tasks.

3. Task B153 meets the criteria for essential training on the basis of TE and TD but the training aircraft is not capable of performing the task (can be trained for knowledge only).

Bibliography

1. Arkes, Hal R. and Garske, John P. *Psychological Theories of Motivation*. Monterey, California: Brooke/Cole, 1982.

2. Baker, G.A. III. "Instructional System Development: A Challenge for the Training Community," *Proceedings of the First International Technology Congress and Exposition on Applied Learning Technology, 1*: 175. Washington DC: Society for Applied Learning Technology, 1976.

3. Biehler, R. F. *Psychology Applied to Teaching*. Boston: Houghton Mifflin Company, 1971.

4. Bloom, B.S. *Taxonomy of Educational Objectives. Handbook 1: Cognitive Domain*. New York: McKay, 1956.

5. Crooks, Terence J. "The Impact of Classroom Evaluation Practices on Students," *Review of Educational Research. 58*: 438-481 (Winter 1988).

6. Daft, Richard L, and Steers Richard M. *Organizations: A Micro/Macro Approach*. Glenview IL: Scott, Foresman and Company, 1986.

7. Department of Defence. *Defence Report 1988-89*. Canberra: Australian Government Publishing Service, 1989.

8. Department of the Air Force. *Handbook for Air Force Instructors*. AFM 50-62. Washington DC: HQ USAF, 15 January 1984.

9. -----. *Handbook for Designers of Instructional Systems*. AFP 50-58, I-VI. Washington DC: HQ USAF, 15 July 1978.

10. -----. *Instructional Systems Development*. AFM 50-2. Washington DC: HQ USAF, 15 July 1986.

11. -----. *Occupational Analysis*. AFR 35-2. Washington DC: HQ USAF, 23 July 1982.

12. Depuy, Gen William E. Commander of US Army Training and Doctrine Command. "Opening Address," *Proceedings of the First International Technology Congress and Exposition on Applied Learning Technology*. 1: 5. Washington DC: Society for Applied Learning Technology, 1976.

13. Directorate General of Manning-Air Force (RAAF) "Paper On Navigator Category Health." Staff Working Paper. AF86/2796 Pt2. Air Force Office, Canberra, May 1989.

14. Emory, C. William. *Business Research Methods.* (Third Edition). Homewood IL: Richard D Irwin, Inc., 1985.

15. Flanagan, J.C. (Ed). *The Aviation Psychology Program in the Army Air Force (Reports 1 -19).* Washington DC; US Government Printing Office, 1948.

16. Gagne, R.M. and Briggs, L.J. *Principles of Instructional Design.* 2nd Edition. Boston MA: Holt, Rinehart and Winston, 1979.

17. Given, WGCDR K. Personal Correspondence. Department of Defence, Canberra, Australia, 19 July 1990.

18. -----. Telephone Interview. Department of Defence, Canberra, Australia, 19 July 1990.

19. Glaser, Robert and Nitko Anthony J. "Measurement in Learning and Instruction." *Educational Measurement* (Second Edition). Edited by Robert L Thorndike. Washington DC: American Council of Education, 1971.

20. Kaufman, Roger A. *Educational System Planning.* Englewood Cliffs, NJ: Prentice-Hall, Inc., 1972.

21. -----. "Learning Technology and the Military," *Proceedings of the First International Technology Congress and Exposition on Applied Learning Technology.* 1: 207. Washington DC: Society for Applied Learning Technology, 1976.

22. Kimble, G.A. and Garmezy, N. *Principles of General Psychology.* New York: The Ronald Press Company, 1963.

23. Krathwol D.R. *et al. Taxonomy of Educational Objectives: Affective Domain.* New York: McKay 1964.

24. Kulp, R.A. and Childs, C.E. Jr. "An Approach to Curriculum Development for Craft/Clerical and Management Training," *Proceedings of the First International Technology Congress and Exposition on Applied Learning Technology. 1*: 36. Washington DC: Society for Applied Learning Technology, 1976.

25. Mussen, Paul H *et al. Child Development and Personality.* (Sixth Edition) New York NY: Harper and Row, 1984.

26. RAAF Headquarters Support Command. *Occupational Survey Report: Navigators and Air Electronics Officers.* GT3-JA-75-2. Melbourne: Headquarters Support Command (GT3), March 1975.

27. -----. *Occupational Analysis Navigators.* HQSC 1205/13/65/P3. Melbourne: Headquarters Support Command (GT3A), November 1986.

28. -----. *Occupational Survey Report: Navigator Category.* HQSC 1205/13/65/P3. Melbourne: Headquarters Support Command May 1988.

29. -----. *Report of HQSC Validation Team Visits - March 1987.* Melbourne: Headquarters Support Command, 10 September 1987.

30. Headquarters Training Command. Telephone Interview with Command Navigation Training Officer. RAAF Point Cook, 15 January 1990.

31. -----. Telephone Interview with Command Navigation Training Officer. RAAF Point Cook, 11 July 1990.

32. RAAF School of Air Navigation. "Basic Navigator Course-Syllabus Amendments." Covering Letter to Amendment Submission. SAN 36/1/AIR Pt 9 (33). SAN, RAAF East Sale, 23 October 1989.

33. -----. "Report On School Of Air Navigation Validation Tour 1989." SAN 16/10/1/AIR Pt 5 (26). SAN, RAAF East Sale, March 1989.

34. -----. "Summary of Navigator Training Statistics 1983-1989," Minute. RAAF East Sale, March 1990.

35. -----. Telephone Interview with Chief Navigation Instructor. SAN, RAAF East Sale, 14 July 1990.

36. Rowe, WGCDR Graham S. *An Investigation of Ways to Reduce the Failure Rate of Student Pilots During Flying Training in the Royal Australian Air Force.* MS Thesis AFIT/GLM/LSR/87S-63. School of Systems and Logistics, Air Force Institute of Technology (AU), Wright-Patterson AFB, OH, September 1987 (AD-A186540).

37. Royal Australian Air Force. *RAAF Manual of Training Policy and Procedures.* Defence Instruction (AF) AAP 2002.001. RAAF Laverton: RAAF Publications Unit, 29 February 1988.

38. -----. *Suspension Action and Disposal From Training Courses: Policy and Procedures.* Defence Instruction (AF) Personnel 13-26. Canberra: Air Force Office (DT-AF), 25 August 87.

39. -----. *Syllabus of Air Training Course, Navigator.* DI(AF) AAP 2412.100 (AL 2). RAAF Laverton: RAAF Publications Unit, March 1985.

40. School of Systems and Logistics. *Reqirements for the Master of Science Degree.* LS Operating Instruction 50-1 dated 15 April 1989, contained in *1990S/D Graduate Programs Handbook*. AFIT (AU), Wright-Patterson AFB, OH, May 1989.

41. Schumacher S.P. and Glasgow, Z.A. *Handbook for Designers of Instructional Systems.* Valencia, PA: Applied Science Associates, Inc., March 1974.

42. Skinner, B.F. "Operant Behavior," *American Psychologist.* 18: 503-515, 1963.

43. Thorndike, E.L. *Animal Intelligence.* New York: McGraw Hill, 1911.

44. University of Chicago. *Encyclopaedia Britannica.* Edited by Philip H. Goetz. 24; 275. Chicago: University of Chicago, 1985.

Vita

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
September 1990

3. REPORT TYPE AND DATES COVERED
Master's Thesis

4. TITLE AND SUBTITLE
A STUDY TO EVALUATE THE SYLLABUS OF TRAINING FOR THE ROYAL AUSTRALIAN AIR FORCE NAVIGATOR COURSE

5. FUNDING NUMBERS

6. AUTHOR(S)
Richard J. Fogg, Squadron Leader, RAAF

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Air Force Institute of Technology
WPAFB OH 45433-6583

8. PERFORMING ORGANIZATION REPORT NUMBER
AFIT/GLM/LSR/90S-19

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*
The primary aim of this thesis was to address a need for an independent evaluation of the RAAF Navigator Course which was expressed by staff officers in Air Force Office in March 1989. The study first reviewed the literature on education and training with emphasis on learning theory and the design of instructional systems. The Instructional Systems Development (ISD) process, used by the USAF for the design of training courses, was found to be compatible with RAAF training policy and was therefore selected as a basis for the evaluation. Occupational Analysis data from a 1988 study of the RAAF Navigator Category, and the content and theoretical construct of the syllabus of training for the RAAF Navigator Course were then analysed on the basis of a four-step process based on the ISD model. Overall, the course was found to meet its aim: graduates capable of performing the basic duties of a junior commissioned navigator in the RAAF. However, some theoretical shortcomings in the syllabus, and therefore the course, were identified and recommendations based on these findings were proposed.

14. SUBJECT TERMS
Royal Australian Air Force, Navigator Training, Training, Military Training

15. NUMBER OF PAGES
115

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL